Experimental and Research Station,

Nursery & Market Garden Industries' ~ ~ Development Society, Limited. ~ ~

Turner's Hill, Cheshunt, Herts.

Tenth Annual Report, 1924.

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Experimental and Research Station.

SCIENTIFIC STAFF.

Director :
W. F. Bewley, D.Sc. (Dunelm).

Entomologist :
E. R. Speyer, M.A. (Oxon.).

Chemist :
O. Owen, M.Sc. (Wales), A.I.C.

Mycologist :
R. W. Butcher, B.Sc. (London).

Research Assistant for Carbon Dioxide Investigations :
P. H. Williams, B.Sc. (London).

Voluntary Assistants :
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H. L. White, B.A. (Cantab.).

Secretary :
Helen Marchant.

Glasshouse Working Staff :

Foreman .....A. A. Richards.
Cucumber Grower.....J. H. Smith.
Tomato Grower.....A. E. Judd.
Tomato Grower.....W. R. Everard.
Tomato Assistant.....G. J. Wilkinson.
Assistant .....G. Walpole.

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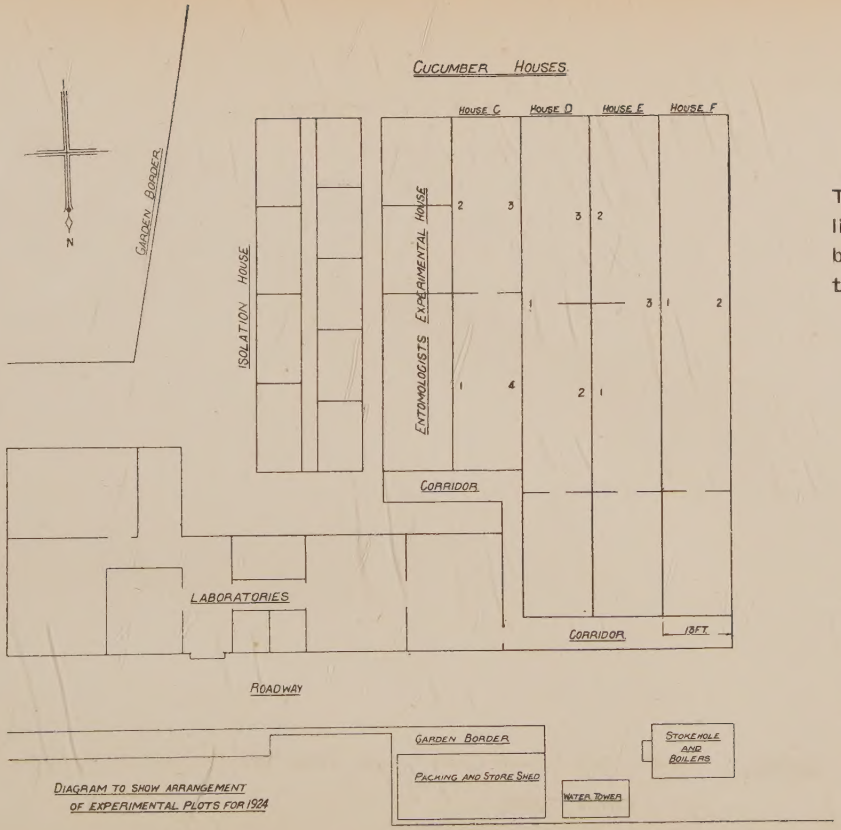
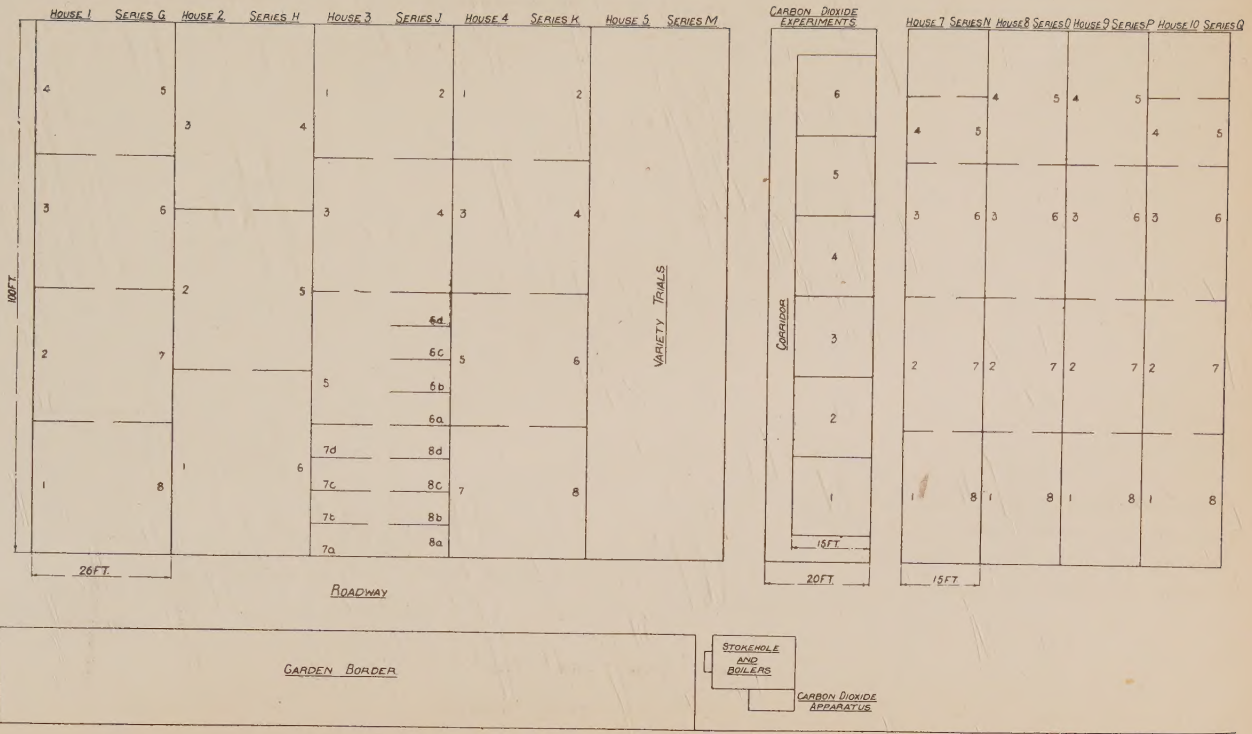


DIAGRAM TO SHOW ARRANGEMENT OF EXPERIMENTAL PLOTS FOR 1924

NOTE.

The Tomato Houses are built in line with the Cucumber Houses. but for convenience of printing they are shown on separate pages.

TOMATO HOUSES



Introduction.

SINCE its inception in 1914 the Nursery and Market Garden Industries Development Society has continued to make steady progress.

High cost of production and severe competition is convincing growers of the necessity for continued research in all matters affecting the welfare of their crops. The loss of only half-a-pound of tomatoes per plant may decide between profit and loss on the year's working, and all attempts to improve crops and prevent the ravages of diseases and pests are worthy of unstinted support.

It is a pleasure to record the greater interest in the work of the Experimental Station which is now being shown by growers all over the country.

Investigations of pests and diseases conducted at the Station have already provided control measures which have earned the approval of those who have tried them. Recent results of the manurial and crop management trials are also distinctly encouraging. It is hoped, therefore, that every grower will endeavour to see more of the work in the future, and so assist us to achieve that close co-operation between scientific worker and grower which is essential to progress.

New members are constantly being enrolled and income from this source is increasing each year. The increased activity of the staff has added considerably to the cost of maintenance and more support is needed if the investigations are to be developed to the fullest extent. The Capital Debt at the end of 1924 was £1,432, being £413 more than at the end of the previous year. Capital expenditure during the year amounted to £490; this was caused by the installation of electric power and by the purchase of a foreman's house. Housing accommodation in the vicinity of the Station is so inadequate, that the welfare of the staff is seriously affected. Any assistance that local growers can offer to correct this will be most

gratefully received. The Maintenance Debt was £1,000, being £287 more than at the end of 1923; this was largely covered by unpaid subscriptions and other monies which have since been received.

During the past few years it has been obvious to all concerned that the existing laboratory is too small to accommodate the staff appointed to conduct the extended programme of research which is now in hand. After prolonged discussion, the Committee of Management decided to erect new laboratories if the necessary funds could be obtained. Plans were prepared of a suitable extension estimated to cost £4,800 on completion, and details were submitted to the Ministry of Agriculture together with an application for financial assistance. The application was generously received, and on the recommendation of the Development Commissioners and the Ministry of Agriculture the Treasury granted a sum of £2,800 on condition the remaining £2,000 was provided by the growers. This was agreed to by the Committee of Management and a subscription list was opened. A sum of £700 was quickly raised and on the first £1,000 being guaranteed permission was given to commence building. The new laboratories are now being erected and will be completed in 1925. An appeal for further subscriptions has been issued. It is hoped that growers will show their appreciation of the work of the Station by liberal donations to the extension fund.

The tomato experiments, which were revised in 1923, have been continued. The results during the present season indicate that information of considerable practical importance will be forthcoming on the completion of the present series of experiments. Our knowledge of the cause of blotchy ripening of tomato fruits has been extended and the value of potassic and nitrogenous fertilisers in correcting this disorder has been confirmed.

Tomato experiments in the houses erected during the winter of 1922-23 have emphasized the high manurial value of well-rotted turf. Plots into which turf was dug in

January, 1923, and which remained fallow during that season yielded a full 50 ton per acre crop during 1924 without further manurial treatment.

The cucumber experiments commenced in 1922 were continued. The best results were obtained by manuring and steaming the base, and by spreading and steaming last season's beds.

Investigations designed to determine if increased crops can be obtained by increasing the concentrations of carbon dioxide in glasshouse atmospheres have been continued since 1922. During the past season there have been indications that increased yields may result from this treatment. A commercial apparatus designed to supply large quantities of carbon dioxide to glasshouses has been tested and found to be unsatisfactory in its present state.

Considerable advances have been made in the investigations concerned with the control of the red spider pest of glasshouses. Naphthalene vapours destroy all stages of the mite from the egg to the red hibernating forms, and the vaporisation of this compound has yielded excellent results in commercial nurseries. The trials have been conducted mainly with cucumbers but there are indications that the treatment is effective with other crops. The experiments are merely in the preliminary stage ; a good deal of work is necessary before definite conclusions can be put forward.

The present year, 1924, marks the conclusion of the first ten years in the history of the Experimental Station, and it is pleasing to record our appreciation of the valuable assistance rendered by growers generally and the Committee of Management in particular. The President, Mr. H. O. Larsen, has remained in office since 1914, while Mr. C. H. Shoults has been Hon. Treasurer since 1915. Only those most intimately connected with the Station realise how much their assistance has influenced its progress.

Our sincere thanks are due to them and also to the various growers and scientific gentlemen who have served on the Committee of Management.

A Retrospect, 1915—1924.

The passing of 1924 marks the termination of the first decade of the existence of this Station and it is fitting that some reference should be made to the progress during this period.

About the year 1914 the experiments on soil sterilisation conducted by Sir John Russell and his colleagues at the Rothamsted Experimental Station aroused considerable interest in the Lea Valley. The growers at once saw the practical value of scientific research and determined to provide means whereby their own peculiar problems could be studied. In the Spring of 1914 a suitable site was secured and a small laboratory erected. Such an enterprise could only be undertaken at the expense of a considerable amount of time on the part of those closely connected with it. Whilst it may seem invidious to single out any individual as more worthy of mention than another, tribute should be paid to the unstinted help given by those who served on the first Committee. Mention must also be made of the valuable services rendered by the late Mr. W. B. Randall, who, although not on the first Committee, was an active member from 1916 to the time of his death in March, 1921. His boundless enthusiasm was a source of pleasure to all who came in contact with him.

Mr. A. B. Lister was appointed Director of the Station in 1914 and continued in this capacity until the re arrangement of staff in 1919, when owing to the development of Nursery Trades, Ltd., and other bodies which he served, he relinquished part of his duties and became Advisory Officer. During his term of office he devoted much time and energy to the Station's interests, at a time when circumstances were all against scientific investigation and progress. He was joined by Mr. F. G. Gregory in 1916, who investigated the physiological conditions under which cucumbers are forced for market. Important data were published in 1917 concerning the effect of humidity, light and temperature on fruit production and on the growth rates of stems and leaf surfaces.

In 1917 the need for developing the study of soil sterilisation was felt by all and the late Mr. W. B. Randall generously offered to provide the necessary funds for such work. This offer was at once accepted and Mrs. D. J. Matthews was appointed to carry out the necessary investigations. Although appointed on the staff of the Experimental Station it was

found convenient for her to work at Rothamsted under the direction of Sir John Russell. The work lasted until 1920 and much valuable information was obtained.

The termination of the war and consequent improvement of working conditions led to the organisation of the Scientific Staff of the Station in 1919, when Dr. Ll. Lloyd was appointed Entomologist and Dr. W. F. Bewley Mycologist; Mr. A. B. Lister became Advisory Officer. Dr. Lloyd first studied the tomato moth pest and elaborated effective control measures, which are now used extensively in the industry. In 1920 he investigated methods for controlling white fly and was able to show that this pest can be successfully combated by cyanide fumigation without injury to the plant, provided certain well-defined conditions are imposed. In 1921 his attention was directed to red spider but he had not completed the work when he resigned his appointment and went to Central Africa to study the tsetse fly in relation to "sleeping sickness." Before leaving, however, he devised methods for spraying cucumber plants and cleaning the empty houses, which were of considerable value in fighting red spider.

Dr. Bewley began his investigations by an examination of the causes of "damping off" of tomato seedlings and discovered reliable methods for controlling it. He also studied "stripe" disease of the tomato and showed that suitable dressings of sulphate of potash will suffice to keep it under control. In 1920 he investigated "sleepy disease" or *Verticillium* wilt of the tomato and devised certain cultural methods for its control. It was found that the disease is associated with low temperatures and may be kept in hand by inducing a temperature higher than 77°F. During this year he was joined by Mr. W. Buddin and with him examined large numbers of nursery water supplies, showing that many were contaminated with disease organisms and constituted important sources of infection. During 1921, a study was made of cucumber "leaf spot," soft rot of the arum and canker of the melon, whilst an investigation of mosaic disease of the cucumber and tomato was commenced.

In 1921, Mr. A. B. Lister resigned his post as Advisory Officer and Dr. Bewley was appointed Director of the Station; Mr. E. R. Speyer became Entomologist in place of Dr. Lloyd.

Mr. Speyer continued the investigations of the control of red spider and also studied the woodlouse pest.

At the request of the Ministry of Agriculture, who provided a special grant, investigations were started to see if increased crops could be obtained by artificially increasing the concentration of carbon dioxide in glasshouse atmospheres. The preliminary work was conducted by Mr. L. B. Timmis in 1922 and continued by Mr. Owen in 1923. During 1922 and 1923 the experiments in the Station glasshouses were revised and the new series are providing promising results.

The year 1923 is noteworthy in the history of the Station as the work was re-organised and additions were made to the Station staff. This was largely due to the generosity of the Ministry of Agriculture in providing an increased grant. Five new glasshouses were also erected, four being of the "aeroplane" type, and one of special construction suitable for physiological experiments. During this year, Mr. O. Owen was appointed Chemist to the Station and Mr. P. H. Williams joined the staff as assistant for the carbon dioxide investigations.

In 1924 Mr. R. W. Butcher was appointed Mycologist and it was possible to extend the work of this department. The carbon dioxide investigations were continued and promising results were obtained which will be tested still further during 1925.

Mr. Speyer was assisted by Mr. Owen in the red spider investigations and towards the end of the season it was found that large numbers of the spider were killed by vaporising naphthalene in cucumber houses. Large scale experiments were conducted on commercial nurseries and excellent results were obtained. The method may still require adjustment and the work will be continued until the best conditions for naphthalene fumigation have been devised. Mr. Speyer also devised a satisfactory poisoned bait for killing woodlice. The investigations of the Station staff during these ten years have been carried to satisfactory conclusions and the benefits bestowed upon the industry are clearly recognised.

Better conditions for work are being provided by the laboratory extension and we may look forward hopefully to the future solution of many problems affecting the prosperity of the industry. It is gratifying to see the increased interest shown by growers in the activities of the Station and it is hoped that this will increase until every single grower of glasshouse produce is an ardent supporter.

H. O. Larsen.
C. H. Shoults.

DIRECTOR'S REPORT.

Experimental Results of 1924.

The practice of grading the tomato fruits from the experimental plots adopted in 1921 was continued during the present season. The fruits are collected from each plot in numbered baskets and graded into seven grades as follows:—

A.—"Pinks" number 5 to 7 and "Pink and Whites" 8 to 10 to the lb. These are the best quality of fruit in size, shape and colour; "Pinks" being slightly larger than "Pink and Whites."

B.—"Whites." These are fruit of good shape and colour but smaller than "Pink and Whites."

C.—"Blues." This grade consists of fruit of good colour but larger and more irregular in shape than Grade A.

D.—"Roughs." Small misshapen fruits about the size of cherries.

E.—Blotchy fruits which ripen irregularly.

F.—Fruits showing Blossom End Rot.

G.—Fruit showing lesions of "Stripe Disease."

Manurial Experiments with Tomatoes.

(a) Series J. and K.

As stated in the Ninth Annual Report this series of experiments was revised for 1923. Owing to lack of uniformity in the results during that season and the almost constant appearance of the "black dot" fungus (*Colletotrichum tabificum*) in the roots, it was decided to steam the soil in Series J prior to planting the 1924 crop. It was hoped by this means to eliminate the root fungus and obtain more satisfactory results.

Steaming was performed by the "tray" method during the second week in January, 1924; the crop was planted during the last week in February.

The manurial treatments applied during 1923 were repeated. Plots J3 and J4 were arranged to test the relative value of bone meal and bone flour, as opposed to that of basic slag, for tomatoes.

In plots J6 to J8 an attempt was made to rebuild the unbalanced soil produced by omitting phosphates, nitrogen and potash respectively during the previous seven years. To this end, these plots were sub-divided into four equal sections, one receiving nothing and the other three different quantities of the particular fertiliser in which the plot was deficient. Thus the plot without phosphate, during seven years, was divided into four equal plots, one of which received no phosphate as before, the second had a mixture containing 8% phosphate, the third 16% and the fourth 24%. Plot 7, starved in respect of nitrogen, was divided into four plots; one was left without nitrogen, the others had 1¼%, 2½% and 5% nitrogen respectively. Plot 8, deficient in potash, was divided into four plots, one without, the others with 2½%, 5% and 7% potash respectively.

The ultimate object of these experiments is to determine the correct proportions of phosphatic, nitrogenous and potassic fertilisers in a satisfactory tomato mixture. The results during the past season are detailed in Tables III. to XIX. They are summarised and compared with those of 1923 in Table I.

From these results a series of important deductions may be drawn, the first being a considerable increase in crop as the result of steaming the soil, in all plots save J2, J3 and J4 where the increase is negligible. The reason for this result is obscure in the case of the heavily manured plots J3 and J4, but perhaps not altogether unexpected in J2, which has received no added fertiliser since 1918. Examination of the last column in Table I, in which is shown the percentage increase of the 1924 crop over that of 1923, shows that healthy roots are necessary if full advantage of manurial treatment is to be obtained. This is especially noticeable in the various sections of plots J6 and J7, where the percentage increase of yield of the 1924 crop over that of 1923, increases from 17% to 45% and 14% to 29% respectively as the manurial treatment is increased.

The results from J3 and J4, where an attempt was made to determine the relative value of bone meal and bone flour (J3) and basic slag (J4), confirm those of last season. Under the conditions of the experiment the effect of the two fertilisers appears to be very much the same. In 1923 the basic slag plot gave 8·3% blotchy fruit as against 3·55% from the plot treated with bone meal and bone flour but during 1924 blotchy fruit was almost absent from these plots.

Perhaps the most interesting results of the series are those from plots J6, J7 and J8. During 1923 the yields from

the various sections of these plots lacked uniformity and it was decided to steam the soil and so eliminate certain diseases which might vitiate the experiments. This action has been fully justified by the results during 1924.

In the case of plots J7a to J7d the crop gradually increased in quantity as the amount of sulphate of ammonia was increased, while the proportion of blotchy fruit became less in the same direction. Similar results were obtained from plots J8a to J8d, where increasing dressings of potash increased the yield and decreased the proportion of blotchy fruit. In the case of plots J6a to J6d, where varying amounts of superphosphate were given the results are far from definite and no conclusions can be drawn regarding the effect of phosphates on the crop.

As the best yields resulted from the heaviest dressings of nitrogen and potash, used in the experiments, it will be necessary next season to still further increase the quantities of these nutrients, repeating yearly the gradual increase until a point is reached at which the crop begins to fall. By this means it is hoped to determine the correct proportions of nitrogen, phosphates and potash in a fertilizer mixture for tomatoes. Once this point has been determined it will be necessary to test different sources of these nutrients in order to select those most suitable as tomato foods.

The experiments of 1916–1920 showed higher yields from plots J7 and K7, where nitrogenous fertilisers were withheld, than from plots J5 and K5 which received dressings of these fertilisers; a fact which seems contradictory to the above results. It must be remembered, however that the present experiments, J7a to J7d, are being conducted with soil starved in respect of nitrogen, while those of 1916 related to new soil, containing an abundance of nitrogenous material.

Series K remained as in previous years, for it was deemed unwise to change these plots, which should constitute valuable testing ground for any results that may accrue from the experiments in Series J or in the new block of tomato houses. The double dressing of complete artificials proved excessive, while the unmanured plot, and those from which nitrogen and potash respectively have been continuously omitted gave low yields. The results are summarised in Table II., and given in more complete detail in Tables XX. to XXVII.

Table I.

Plot Number and Treatment.	Series J. Variety—"Manx Marvel." 1924. Lbs. per Plant during June	July	August	Sept.	October	Lbs. per Plant	Tons per Acre	Total Tons per Acre 1923	% Increase of 1924 over 1923
1. Double Complete Artificials	1.24	2.34	0.72	0.92	0.52	5.74	43.63	37.70	16
2. Unmanured, sterilised with Formaldehyde..	1.14	1.45	0.80	0.61	0.35	4.35	33.05	32.91	—
3. Phosphates as Bone Meal and Bone Flour	1.30	2.45	0.69	0.76	0.55	5.75	43.70	42.86	2
4. Phosphates as Basic Slag	1.44	2.54	0.71	0.71	0.53	5.93	45.04	43.02	5
5. Complete Artificials...	1.28	2.76	0.92	0.81	0.35	6.12	46.42	38.69	20
6a. Complete Artificials without Phosphates	1.58	2.23	0.82	0.52	0.72	5.87	44.60	38.08	17
6b. 8% Phosphates ...	1.45	2.36	0.69	0.76	0.60	5.86	44.53	33.67	32
6c. 16% Phosphates ...	1.59	2.27	0.60	0.66	0.75	5.87	44.60	34.89	26
6d. 24% Phosphates ...	1.58	2.46	0.81	0.76	0.70	6.31	47.92	33.14	45
7a. Complete Artificials without Nitrogen ...	1.79	1.79	0.50	0.68	0.58	5.34	40.56	35.64	14
7b. 1¼% Nitrogen... ...	1.40	2.78	0.64	0.79	0.80	6.41	48.72	43.40	12
7c. 2½% Nitrogen... ...	1.30	2.62	0.81	1.03	0.95	6.71	51.00	38.15	34
7d. 5% Nitrogen	1.45	2.77	0.95	0.97	0.95	7.09	53.88	41.80	29
8a. Complete Artificials without Potash ...	1.38	2.02	0.66	1.22	0.64	5.92	45.00	34.28	31
8b. 2½% Potash	1.31	2.28	0.64	0.85	0.85	5.93	45.19	35.87	26
8c. 5% Potash	1.65	2.31	0.70	0.82	0.67	6.15	46.73	36.86	27
8d. 7% Potash	1.62	2.45	0.81	1.14	0.69	6.71	50.99	44.68	14

Table II.

Plot Number and Treatment.	Series K. Variety—"Manx Marvel."							
	Lbs. per Plant during					Total 1924		Tons per Acre in 1923.
	June	July	August	Sept.	October	Lbs. per Plant	Tons per Acre	
1. Double Complete Artificials	1.25	1.74	0.97	0.55	0.40	4.91	37.34	32.83
2. Unmanured	0.67	1.22	0.72	0.24	0.34	3.19	24.25	25.54
3. Standard treatment plus Complete Artificials ...	1.68	1.92	0.82	0.33	0.42	5.17	39.31	40.05
4. Complete Artificials plus dung	1.71	1.82	0.78	0.28	0.50	5.09	38.68	38.85
5. Complete Artificials ...	1.62	1.66	0.68	1.02	0.44	5.42	41.20	41.03
6. Complete Artificials less Phosphates ...	1.60	1.66	0.73	0.58	0.43	5.00	38.01	36.25
7. Complete Artificials less Nitrogen	1.70	1.06	0.66	0.50	0.41	4.33	32.88	35.72
8. Complete Artificials less Potash	1.13	1.41	0.53	0.55	0.56	4.18	31.78	35.65

Table III.

J1. Double Complete Artificials (Formula II.)

Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.81	1.29	.36	.47	.29	3.22	24.49	56.14
B.	.27	.97	.28	.37	.19	2.08	15.80	36.21
C.	—	.01	—	—	—	.01	.08	.18
D.	.02	.06	.08	.07	.04	.27	2.05	4.70
E.	.14	—	—	—	—	.14	1.06	2.43
F.	—	—	—	—	—	—	—	—
G.	—	.01	—	.01	—	.02	.15	.34
Total	1.24	2.34	.72	.92	.52	5.74	43.63	100

Table IV.

J2. Unmanured, sterilised with Formaldehyde.

Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.12	.25	.27	.19	.19	1.02	7.75	23.45
B.	.03	.20	.15	.21	.13	.72	5.47	16.55
C.	—	.02	.05	.02	—	.09	.68	2.05
D.	—	.04	.10	.12	.03	.29	2.20	6.66
E.	.98	.94	.23	.01	—	2.22	16.87	51.05
F.	.01	—	—	—	—	.01	.08	.24
G.	—	—	—	—	—	—	—	—
Total	1.14	1.45	.80	.61	.35	4.35	33.05	100

Table V.

J3. Phosphates as Bone Meal and Bone Flour.

Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.87	1.30	.36	.36	.26	3.15	23.94	54.77
B.	.40	1.06	.21	.33	.22	2.22	16.87	38.59
C.	—	.01	.02	—	—	.03	.23	.52
D.	.01	.06	.10	.07	.07	.31	2.35	5.37
E.	.01	—	—	—	—	.01	.08	.23
F.	—	—	—	—	—	—	—	—
G.	.01	.02	—	—	—	.03	.23	.52
Total	1.30	2.45	.69	.76	.55	5.75	43.70	100

Table VI.

J4. Phosphates as Basic Slag. Variety "Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.09	1.61	.38	.30	.23	3.61	27.42	60.88
B.	.34	.83	.25	.32	.25	1.99	15.12	33.57
C.	—	.03	.01	—	—	.04	.30	.67
D.	—	.05	.06	.08	.05	.24	1.82	4.04
E.	—	—	—	.01	—	.01	.08	.17
F.	—	—	—	—	—	—	—	—
G.	.01	.02	.01	—	—	.04	.30	.67
Total	1.44	2.54	.71	.71	.53	5.93	45.04	100

Table VII.

J5. Complete Artificials. Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.92	1.72	.51	.40	.15	3.70	28.11	60.57
B.	.31	.91	.28	.34	.17	2.01	15.20	32.74
C.	.01	.04	.01	—	—	.06	.46	.99
D.	.02	.08	.11	.07	.03	.31	2.35	5.06
E.	.01	.01	—	—	—	.02	.15	.32
F.	—	—	—	—	—	—	—	—
G.	.01	—	.01	—	—	.02	.15	.32
Total	1.28	2.76	.92	.81	.35	6.12	46.42	100

Table VIII.

J6a. Complete Artificials without Phosphates.

Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.21	1.36	.49	.20	.39	3.65	27.72	62.16
B.	.30	.78	.22	.25	.26	1.81	13.75	30.83
C.	—	.02	.02	—	—	.04	.31	.69
D.	.03	.04	.04	.06	.04	.21	1.60	3.59
E.	.04	.01	.05	—	.03	.13	.99	2.22
F.	—	—	—	.01	—	.01	.08	.18
G.	—	.02	—	—	—	.02	.15	.33
Total	1.58	2.23	.82	.52	.72	5.87	44.60	100

Table IX.

J6b. 8% Phosphates. **Variety—"Manx Marvel."**

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.99	1.23	.35	.31	.28	3.16	24.00	53.89
B.	.45	1.07	.25	.33	.28	2.38	18.09	40.62
C.	—	.03	—	—	—	.03	.23	.52
D.	.01	.03	.05	.10	.02	.21	1.60	3.60
E.	—	—	.04	.02	.02	.08	.61	1.37
F.	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—
Total	1.45	2.36	.69	.76	.60	5.86	44.53	100

Table X.

J6c. 16% Phosphates. Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.04	1.39	.31	.26	.36	3.36	25.53	57.24
B.	.50	.86	.22	.30	.36	2.24	17.01	38.14
C.	—	—	.03	—	—	.03	.23	.52
D.	.02	.01	.04	.10	.03	.20	1.52	3.41
E.	—	.01	—	—	—	.01	.08	.18
F.	.01	—	—	—	—	.01	.08	.18
G.	.02	—	—	—	—	.02	.15	.33
Total	1.59	2.27	.60	.66	.75	5.87	44.60	100

Table XI.

J6d. 24% Phosphates. Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.27	1.65	.52	.44	.37	4.25	32.28	67.38
B.	.31	.69	.20	.25	.28	1.73	13.14	27.43
C.	—	.06	.03	—	—	.09	.68	1.42
D.	—	.03	.05	.06	.05	.19	1.44	3.01
E.	—	.03	—	—	—	.03	.23	.44
F.	—	—	—	—	—	—	—	—
G.	—	—	.01	.01	—	.02	.15	.32
Total	1.58	2.46	.81	.76	.70	6.31	47.92	100

Table XII.

J7a. Complete Artificials without Nitrogen.

Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.52	1.46	.34	.41	.27	4.00	30.38	74.89
B.	.20	.26	.12	.18	.17	.93	7.06	17.41
C.	—	.01	—	—	—	.01	.08	.20
D.	—	—	.01	.05	.11	.17	1.29	3.18
E.	.06	.06	.03	.04	.01	.20	1.52	3.75
F.	.01	—	—	—	—	.01	.08	.20
G.	—	—	—	—	.02	.02	.15	.37
Total	1.79	1.79	.50	.68	.58	5.34	40.56	100

Table XIII.

J7b. 1¼% Nitrogen. **Variety—"Manx Marvel."**

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.16	1.78	.38	.42	.32	4.06	30.86	63.36
B.	.23	.87	.20	.30	.36	1.96	14.90	30.59
C.	—	.06	—	—	.01	.07	.53	1.08
D.	—	—	.04	.05	.10	.19	1.44	2.95
E.	—	.03	.01	.01	—	.05	.38	.78
F.	.01	—	—	—	—	.01	.08	.16
G.	—	.04	.01	.01	.01	.07	.53	1.08
Total	1.40	2.78	.64	.79	.80	6.41	48.72	100

Table XIV.

J7c. 2½% Nitrogen. Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.99	1.91	.48	.66	.55	4.59	34.88	68.39
B.	.30	.66	.29	.30	.31	1.86	14.14	27.72
C.	—	.03	.01	—	—	.04	.30	.59
D.	—	.01	.03	.07	.07	.18	1.37	2.69
E.	—	—	—	—	.01	.01	.08	.16
F.	.01	—	—	—	—	.01	.08	.16
G.	—	.01	—	—	.01	.02	.15	.29
Total	1.30	2.62	.81	1.03	.95	6.71	51.00	100

Table XV.

J7d. 5% Nitrogen. Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.17	2.03	.54	.61	.54	4.89	37.16	68.98
B.	.25	.68	.34	.30	.35	1.92	14.59	27.08
C.	.01	.05	.03	—	—	.09	.68	1.26
D.	—	.01	.03	.06	.06	.16	1.22	2.26
E.	.01	—	.01	—	—	.02	.15	.27
F.	.01	—	—	—	—	.01	.08	.15
G.	—	—	—	—	—	—	—	—
Total	1.45	2.77	.95	.97	.95	7.09	53.88	100

Table XVI.

J8a. Complete Artificials without Potash.

Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.95	1.33	.36	.65	.34	3.63	27.59	61.31
B.	.13	.25	.11	.31	.19	.99	7.53	16.73
C.	—	.01	—	.04	—	.05	.38	.84
D.	.02	—	.03	.04	.02	.11	.84	1.87
E.	.27	.43	.10	.18	.09	1.07	8.13	18.07
F.	—	—	—	—	—	—	—	—
G.	.01	—	.06	—	—	.07	.53	1.18
Total	1.38	2.02	.66	1.22	.64	5.92	45.00	100

Table XVII.

J8b. 2½% Potash. **Variety—"Manx Marvel."**

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.00	1.59	.35	.52	.53	3.99	30.43	67.34
B.	.22	.43	.19	.24	.24	1.32	10.04	22.21
C.	—	.03	—	—	—	.03	.23	.51
D.	.02	.02	.07	.04	.03	.18	1.37	3.03
E.	.05	.20	.03	.04	.05	.37	2.81	6.22
F.	.01	—	—	—	—	.01	.08	.18
G.	.01	.01	—	.01	—	.03	.23	.51
Total	1.31	2.28	.64	.85	.85	5.93	45.19	100

Table XVIII.

J8c. 5% Potash. Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.28	1.63	.42	.50	.54	4.37	33.20	71.04
B.	.21	.46	.20	.25	.10	1.22	9.28	19.86
C.	—	.13	—	—	.01	.14	1.06	2.27
D.	.02	.02	.04	.04	.02	.14	1.06	2.27
E.	.13	.07	.04	.03	—	.27	2.05	4.39
F.	—	—	—	—	—	—	—	—
G.	.01	—	—	—	—	.01	.08	.17
Total	1.65	2.31	.70	.82	.67	6.15	46.73	100

Table XIX.

J8d. 7% Potash. Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.20	1.74	.43	.74	.51	4.62	35.11	68.85
B.	.20	.52	.19	.33	.15	1.39	10.56	20.71
C.	.03	.08	—	—	—	.11	.84	1.65
D.	—	—	.15	.06	.03	.24	1.82	3.57
E.	.14	.08	.01	.01	—	.24	1.82	3.57
F.	—	—	—	—	—	—	—	—
G.	.05	.03	.03	—	—	.11	.84	1.65
Total	1.62	2.45	.81	1.14	.69	6.71	50.99	100

Table XX.

K1. Double Complete Artificials. Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.88	1.16	.50	.22	.20	2.96	22.50	60.26
B.	.35	.54	.33	.26	.16	1.64	12.47	33.39
C.	—	.02	.01	—	—	.03	.23	.62
D.	—	.01	.10	.07	.03	.21	1.60	4.28
E.	—	.01	.02	—	—	.03	.23	.62
F.	—	—	—	—	—	—	—	—
G.	.02	—	.01	—	.01	.04	.31	.83
Total	1.25	1.74	.97	.55	.40	4.91	37.34	100

Table XXI.

K2. Untreated. Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.31	.62	.38	.11	.13	1.55	11.78	48.59
B.	.04	.13	.16	.09	.16	.58	4.41	18.19
C.	.02	.10	.02	—	.01	.15	1.14	4.70
D.	—	—	.06	.03	.04	.13	.99	4.07
E.	.30	.37	.10	.01	—	.78	5.93	24.45
F.	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—
Total	.67	1.22	.72	.24	.34	3.19	24.25	100

Table XXII.

K3. Standard Treatment and Complete Artificials.
Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.07	1.34	.47	.14	.18	3.20	24.33	61.90
B.	.59	.54	.29	.15	.17	1.74	13.23	33.66
C.	—	—	—	—	.01	.01	.08	.20
D.	.01	.02	.06	.04	.06	.19	1.44	3.66
E.	—	.02	—	—	—	.02	.15	.38
F.	.01	—	—	—	—	.01	.08	.20
G.	—	—	—	—	—	—	—	—
Total	1.68	1.92	.82	.33	.42	5.17	39.31	100

Table XXIII.

K4. Complete Artificials plus Dung. Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.25	1.28	.40	.10	.21	3.24	24.62	63.65
B.	.44	.52	.31	.15	.22	1.64	12.46	32.21
C.	—	—	—	—	.01	.01	.08	.21
D.	—	.02	.06	.03	.06	.17	1.29	3.33
E.	—	—	.01	—	—	.01	.08	.21
F.	—	—	—	—	—	—	—	—
G.	.02	—	—	—	—	.02	.15	.39
Total	1.71	1.82	.78	.28	.50	5.09	38.68	100

Table XXIV.

K5. Complete Artificials. Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.40	1.28	.41	.58	.21	3.88	29.50	71.61
B.	.21	.36	.20	.38	.20	1.35	10.26	24.90
C.	—	.01	.01	—	—	.02	.15	.36
D.	—	—	.06	.06	.03	.15	1.14	2.77
E.	—	—	—	—	—	—	—	—
F.	—	—	—	—	—	—	—	—
G.	.01	.01	—	—	—	.02	.15	.36
Total	1.62	1.66	.68	1.02	.44	5.42	41.20	100

Table XXV.

K6. Complete Artificials less Phosphates.

Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.34	1.34	.41	.33	.17	3.59	27.30	71.83
B.	.25	.27	.25	.21	.22	1.20	9.11	23.96
C.	—	.03	.01	—	—	.04	.31	.82
D.	—	—	.04	.04	.04	.12	.91	2.39
E.	.01	.01	.01	—	—	.03	.23	.61
F.	—	—	—	—	—	—	—	—
G.	—	.01	.01	—	—	.02	.15	.39
Total	1.60	1.66	.73	.58	.43	5.00	38.01	100

Table XXVI.

K7. Complete Artificials less Nitrogen.

Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.56	.85	.40	.26	.17	3.24	24.60	74.81
B.	.10	.18	.20	.18	.20	.86	6.53	19.87
C.	—	.01	—	—	—	.01	.08	.24
D.	—	.01	.04	.05	.03	.13	.99	3.01
E.	.04	.01	.02	.01	.01	.09	.68	2.07
F.	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—
Total	1.70	1.06	.66	.50	.41	4.33	32.88	100

Table XXVII.

K8. Complete Artificials less Potash.

Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.81	.86	.25	.22	.20	2.34	17.78	59.95
B.	.12	.24	.19	.24	.22	1.01	7.68	24.16
C.	—	.07	—	—	.01	.08	.61	1.92
D.	—	—	.06	.06	.07	.19	1.45	4.56
E.	.20	.20	.02	.03	.06	.51	3.88	12.21
F.	—	—	—	—	—	—	—	—
G.	—	.04	.01	—	—	.05	.38	1.20
Total	1.13	1.41	.53	.55	.56	4.18	31.78	100

Top-dressing versus Base-dressing.

This experiment is of considerable interest, insomuch as the two plots receiving base manure only have again given the largest weight of fruit. These two plots are situated in the centre of the house, and the higher yields may be in some respect due to the position they occupy. It is, therefore, necessary to repeat the experiment for another year, applying base manure only to the two plots which have given low yields during the past two seasons. Results are detailed on Tables XXIX.—XXXIV.

Variety Trials.

These trials, which were commenced in 1923, have for their object the testing of new varieties against those that have stood the test for commercial excellence. Twelve varieties were tested in 1923, but this number proved unwieldly in a small house; during 1924 the number was reduced to seven.

An attack of the tomato knot eelworm in this house during 1923 necessitated the sterilisation of the soil, which was effected by steaming. The average crop for the house last year was 35·5 tons per acre. After steaming it has yielded 42 tons per acre this year, being an increase of 18% on last season's crop.

All the varieties tested gave a crop of over 40 tons per acre, except Comet, which although of excellent quality does not produce a high yield under the conditions operative at the Experimental Station. Radio gave the highest yield of 45·6 tons per acre. It produced good quality fruit but needs further selection. The results are summarised in Table XXXV. and detailed in Tables XXXVI.—XLIX.

Table XXIX.

H1. Top-dressing only. **Variety—"Manx Marvel."**

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.76	1.26	.46	.34	.25	3.07	23.33	57.61
B.	.23	.77	.21	.21	.19	1.61	12.23	30.19
C.	—	.01	.01	.01	—	.03	.23	.57
D.	—	.06	.08	.07	.07	.28	2.13	5.26
E.	.02	.02	.01	.02	.07	.14	1.06	2.62
F.	.01	—	—	—	—	.01	.08	.20
G.	.07	.04	.02	.05	.01	.09	1.44	3.55
Total	1.09	2.16	.79	.70	.59	5.33	40.50	100

Table XXX.

H2. Base-dressing only. **Variety—"Manx Marvel."**

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.60	1.90	.61	.39	.36	3.86	29.34	62.98
B.	.18	.78	.34	.24	.20	1.74	13.22	28.37
C.	—	.06	.02	—	—	.08	.61	1.31
D.	.01	.04	.08	.06	.05	.24	1.82	3.91
E.	—	.04	.01	.01	.02	.08	.61	1.31
F.	.01	—	—	—	—	.01	.08	.17
G.	.05	.05	.01	.01	—	.12	.91	1.95
Total	.85	2.87	1.07	.71	.63	6.13	46.59	100

Table XXXI.

H3. Base and Top-dressing. Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.56	1.66	.57	.40	.35	3.54	26.97	64.86
B.	.16	.63	.25	.16	.23	1.43	10.89	26.19
C.	—	.02	—	—	—	.02	.15	.36
D.	.01	.05	.09	.06	.07	.28	2.13	5.12
E.	—	.04	.01	.01	.03	.09	.69	1.65
F.	—	—	—	—	—	—	—	—
G.	.03	.02	.01	.04	—	.10	.76	1.82
Total	.76	2.42	.93	.67	.68	5.46	41.59	100

Table XXXII.

H4. Top-dressing only. Variety—"Manx Marvel."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.65	1.55	.47	.66	.44	3.77	28.65	67.95
B.	.15	.48	.25	.22	.26	1.36	10.33	24.49
C.	—	.01	.01	—	—	.02	.15	.36
D.	.01	.03	.07	.09	.05	.25	1.90	4.51
E.	—	.01	.01	.03	.03	.08	.61	1.44
F.	—	—	—	—	—	—	—	—
G.	.02	.03	—	.01	.01	.07	.53	1.25
Total	.83	2.11	.81	1.01	.79	5.55	42.17	100

Table XXXIII.

H5. Base only. **Variety—"Manx Marvel."**

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.85	1.55	.54	.46	.32	3.72	28.30	63.36
B.	.18	.70	.24	.27	.20	1.59	12.10	27.09
C.	—	.03	.02	.01	.01	.07	.53	1.18
D.	—	.03	.08	.08	.10	.29	2.21	4.95
E.	—	.02	.01	.01	.02	.06	.46	1.03
F.	.01	—	—	—	—	.01	.08	.18
G.	.05	.06	—	.01	.01	.13	.99	2.21
Total	1.09	2.39	.89	.84	.66	5.87	44.67	100

Table XXXIV.

H6. Base and Top-dressing. **Variety—"Manx Marvel."**

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.23	1.50	.33	.44	.35	3.85	29.28	67.07
B.	.23	.68	.15	.21	.16	1.43	10.88	24.92
C.	—	.01	.01	—	.01	.03	.23	.53
D.	—	.03	.06	.09	.06	.24	1.83	4.19
E.	—	.02	.01	.03	.01	.07	.53	1.21
F.	—	—	—	—	—	—	—	—
G.	.04	.05	—	.03	—	.12	.91	2.08
Total	1.50	2.29	.56	.80	.59	5.74	43.66	100

Manurial Treatment of Series H.

Base Manure. (H2, H3, H5 and H6):—

1 lb. Lime per sq. yd.
No Stable Manure.
¾ lb. per sq. yd. of the following mixture:—
1 part Bone Meal.
1 part Bone Flour.
1 part Hoof and Horn.
1 part Sulphate of Potash.

Top-dressing. (H1, H3, H4 and H6):—

Mulch of Stable Manure.
Eight dressings, each consisting of 2 ozs. per sq. yd. of the following mixture:—
3 parts Sulphate of Ammonia.
2 parts Dried Blood.
7 parts 30% Superphosphate.
5 parts Pure Dissolved Bones.
½ part Bone Flour.
2½ parts Sulphate of Potash.

Table XXXV.

Variety Trials.

VARIETY	Lbs. per Plant.	Tons per Acre.
Kondine Red	5·61	42·63
Comet	4·86	36·94
Radio	6·00	45·60
Riverside Favourite ...	5·75	43·70
Balch's Gem	5·27	40·05
Le Croix	5·62	42·67
Ailsa Craig...	5·64	42·82

Table XXXVI.

M1. Variety—"Kondine Red" (Balch's).

Grade.	Lbs. per Plant.						Tons per Acre	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.77	.75	.58	.32	.19	3.61	27.43	63.34
B.	.29	.25	.21	.10	.10	.95	7.21	16.64
C.	.41	.21	.17	.05	.01	.85	6.46	14.91
D.	.01	—	.03	.03	.03	.10	.76	1.76
E.	.02	.04	.05	—	—	.11	.84	1.94
F.	.03	—	—	—	—	.03	.23	.53
G.	.04	—	.01	—	—	.05	.38	.88
Total	2.57	1.25	1.05	.50	.33	5.70	43.31	100

Table XXXVII.

M2. Variety—"Comet."

Grade.	Lbs. per Plant.						Tons per Acre	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.60	.70	.58	.22	.08	3.18	24.17	63.10
B.	.24	.11	.17	.10	.03	.65	4.94	12.90
C.	.42	.29	.16	.08	.02	.97	7.37	19.24
D.	.01	—	.03	.03	.01	.08	.61	1.60
E.	.09	—	—	—	—	.09	.68	1.78
F.	—	—	—	—	—	—	—	—
G.	.07	—	—	—	—	.07	.53	1.38
Total	2.43	1.10	.94	.43	.14	5.04	38.30	100

Table XXXVIII.

M3. Variety—"Radio."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	2.02	.98	.57	.08	.10	3.75	28.50	60.57
B.	.68	.49	.33	.04	.15	1.69	12.84	27.30
C.	.21	.20	.05	.01	.04	.51	3.88	8.25
D.	.02	.02	.07	.01	.03	.15	1.14	2.43
E.	.03	.02	—	—	—	.05	.38	.81
F.	—	—	—	—	—	—	—	—
G.	.04	—	—	—	—	.04	.30	.64
Total	3.00	1.71	1.02	.14	.32	6.19	47.04	100

Table XXXIX.

M4. Variety—"Riverside Favourite."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.82	.82	.46	.25	.10	3.45	26.22	56.93
B.	.19	.30	.24	.14	.09	.96	7.29	15.82
C.	.58	.68	.11	.06	.01	1.44	10.94	23.76
D.	—	.01	.03	.03	.04	.11	.84	1.83
E.	.04	.14	.02	—	—	.10	.76	1.66
F.	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—
Total	2.63	1.95	.86	.48	.24	6.06	46.05	100

Table XL.

M5. Variety—"Balch's Gem."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.83	1.16	.45	.12	.17	3.73	28.35	69.08
B.	.44	.44	.23	.09	.12	1.32	10.03	24.43
C.	.05	.01	.05	—	—	.11	.84	2.05
D.	—	.01	.04	.01	.03	.09	.68	1.66
E.	.02	.05	—	—	—	.07	.53	1.29
F.	—	—	—	—	—	—	—	—
G.	.08	—	—	—	—	.08	.61	1.49
Total	2.42	1.67	.77	.22	.32	5.40	41.04	100

Table XLI.

M6. Variety—"Le Croix."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.73	.89	.47	.29	.16	3.54	26.90	63.11
B.	.45	.69	.30	.21	.11	1.76	13.38	31.39
C.	.01	.04	.06	—	.01	.12	.91	2.13
D.	—	.01	.08	.08	.02	.19	1.44	3.37
E.	—	—	—	—	—	—	—	—
F.	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—
Total	2.19	1.63	.91	.58	.30	5.61	42.63	100

Table XLII.

M7. Variety—"Ailsa Craig." (Selection.)

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.61	.70	.47	.23	.13	3.14	23.86	53.50
B.	.29	.20	.22	.18	.09	.98	7.45	16.70
C.	.64	.56	.15	.07	.01	1.43	10.86	24.35
D.	.03	.02	.05	.05	.01	.16	1.22	2.74
E.	.06	.07	.01	—	—	.14	1.06	2.37
F.	.01	—	—	—	—	.01	.08	.17
G.	.01	—	—	—	—	.01	.08	.17
Total	2.65	1.55	.90	.53	.24	5.87	44.61	100

Table XLIII.

M8. Variety—"Kondine Red" (Balch's).

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.32	.90	.45	.23	.13	3.03	23.03	54.91
B.	.28	.27	.26	.15	.06	1.02	7.75	18.48
C.	.41	.63	.10	.05	—	1.19	9.04	21.55
D.	—	.04	.07	.05	.01	.17	1.29	3.07
E.	—	.04	.02	—	—	.06	.46	1.09
F.	.01	—	—	—	—	.01	.08	.19
G.	.04	—	—	—	—	.04	.30	.71
Total	2.06	1.88	.90	.48	.20	5.52	41.95	100

Table XLIV.

M9. Variety—"Comet."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.48	.79	.40	.13	.16	2.96	22.50	63.25
B.	.24	.18	.14	.05	.06	.67	5.09	14.31
C.	.37	.30	.17	.02	.02	.88	6.69	18.80
D.	.01	.02	.03	.03	.03	.12	.91	2.56
E.	.02	—	—	—	—	.02	.15	.42
F.	.02	—	—	—	—	.02	.15	.42
G.	.01	—	—	—	—	.01	.08	.23
Total	2.15	1.29	.74	.23	.27	4.68	35.57	100

Table XLV.

M10. Variety—"Radio."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	2.04	1.14	.59	.22	.17	4.16	31.60	71.71
B.	.45	.40	.29	.15	.11	1.40	10.64	24.15
C.	.02	.03	.04	—	—	.09	.68	1.55
D.	—	.05	.04	.02	.03	.14	1.06	2.41
E.	—	—	—	—	—	—	—	—
F.	—	—	—	—	—	—	—	—
G.	.01	—	—	—	—	.01	.08	.18
Total	2.52	1.62	.96	.39	.31	5.80	44.06	100

Table XLVI.

M11. Variety—"Riverside Favourite."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.41	.89	.41	.18	.08	2.97	22.57	54.59
B.	.19	.21	.25	.15	.14	.94	7.15	17.29
C.	.30	.91	.14	.03	.01	1.29	9.81	23.72
D.	—	.03	.09	.02	.05	.19	1.44	3.48
E.	—	.04	—	.01	—	.05	.38	.92
F.	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—
Total	1.90	2.08	.89	.39	.28	5.44	41.35	100

Table XLVII.

M12. Variety—"Balch's Gem."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.31	1.17	.54	.19	.12	3.33	25.30	64.79
B.	.37	.41	.19	.13	.11	1.21	9.19	23.54
C.	.05	.06	.02	—	—	.13	.99	2.54
D.	—	.01	.08	.03	.01	.13	.99	2.54
E.	.08	.11	—	—	—	.19	1.44	3.68
F.	—	—	—	—	—	—	—	—
G.	.04	.10	.01	—	—	.15	1.14	2.91
Total	1.85	1.86	.84	.35	.24	5.14	39.05	100

Table XLVIII.

M13. Variety—"Le Croix."

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.88	.91	.44	.21	.09	3.53	26.82	62.72
B.	.45	.68	.30	.16	.13	1.72	13.07	30.31
C.	.04	.04	.02	.01	.02	.13	.99	2.32
D.	—	.04	.06	.06	.01	.17	1.29	3.02
E.	—	.01	—	—	—	.01	.08	.1 8
F.	—	—	—	—	—	—	—	—
G.	.05	—	—	.01	—	.06	.46	1.08
Total	2.42	1.68	.82	.45	.25	5.62	42.71	100

Table XLIX.

M14. Variety—"Ailsa Craig." (Selection.)

Grade.	Lbs. per Plant.						Tons per Acre.	Per Cent. of Total.
	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	1.47	.72	.65	.16	.13	3.13	23.78	57.95
B.	.24	.27	.30	.12	.12	1.05	7.98	19.45
C.	.43	.32	.16	—	.01	.92	6.99	17.03
D.	.02	.01	.10	.01	.02	.16	1.22	2.98
E.	.04	.06	.02	—	.02	.14	1.06	2.59
F.	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—
Total	2.20	1.38	1.23	.29	.30	5.40	41.03	100

Manurial Treatment of Series M.

Base Manure.

1 lb. Lime per sq. yd.
14 lbs. Stable Manure per sq. yd.
¾ lb. per sq. yd. of the following mixture:—
1 part Bone Meal.
1 part Bone Flour.
1 part Hoof and Horn.
1 part Sulphate of Potash.

Top-dressing.

Mulch of Stable Manure.
Eight dressings, each consisting of 2 ozs. per sq. yd. of the following mixture:—
3 parts Sulphate of Ammonia.
2 parts Dried Blood.
7 parts 30% Superphosphate.
5 parts Pure Dissolved Bones.
½ part Bone Flour.
2½ parts Sulphate of Potash.

Investigations concerned with the reduction in yield of the Tomato crop resulting from continuous cultivation on the same soil.

These investigations were begun in 1923, when four new tomato houses were erected at the Station. At the outset the soil was made uniform to a depth of two feet and the turf was dug in. Three houses were well manured, while one received no manurial treatment, the plants being dependent for their food on that existing in the soil or arising from the decomposition of the turf. One quarter of a manured house and one quarter of the unmanured house was allowed to remain fallow during the first season, 1923, In 1924 the treatments were repeated and half of each fallow portion was cropped.

In 1923 the manured houses produced 55·8, 55·2 and 51 tons per acre, while the untreated house gave 32·3 tons per acre. The same houses in 1924 gave 52·3, 50·38 and 49·78 tons per acre for the manured houses and 25·55 tons per acre in the unmanured house. It will be seen that the yield during the second year was lower than that of the first year of cultivation. Whether this is a significant lowering of the yield or is merely due to seasonal variation cannot be decided until next season's results are completed.

The fallowing of the land during 1923 proved beneficial in both the manured and the unmanured house, especially in the latter, where the result is very striking.

In the manured house, the plots fallow during 1923 gave an average of 55·52 tons per acre as against 52·30 tons per acre from plots cultivated during 1923 and 1924. In the unmanured house, the plots fallow in 1923 produced an average crop of 46·36 tons per acre as against 25·55 tons per acre from the rest of the house.

It would appear that the decomposition of the turf during 1923 provided nutrients capable of producing a half crop only, as is shown by the yield of 32·3 tons per acre in 1923. When, however, the products of decomposition of the turf were allowed to accumulate in the soil during twelve months, the crop was 46 tons per acre. These results are of considerable value, because they form the starting-point for future investigation.

The enquiry is being extended during 1925, while chemical and biological investigations of the decomposition of turf are already in progress.

Detailed results are shown in Tables L. to LXXXI.

Table L.

N1. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.38	1.75	.53	.60	.58	.45	4.29	32.60	60.26
B.	.02	.31	.20	.18	.24	.25	1.20	9.12	16.86
C.	.05	.49	.37	.15	.22	.03	1.31	9.96	18.39
D.	—	—	—	.03	.06	.04	.13	1.00	1.84
E.	—	.06	.08	.03	—	—	.17	1.29	2.38
F.	—	—	—	—	—	—	—	—	—
G.	—	.01	.01	—	—	—	.02	.15	.27
Total	.45	2.62	1.19	.99	1.10	.77	7.12	54.12	100

Table LI.

N2. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.47	1.62	.66	.59	.65	.36	4.35	33.06	60.62
B.	.01	.24	.17	.17	.14	.22	.95	7.22	13.22
C.	.08	.50	.35	.31	.27	.04	1.55	11.78	21.58
D.	—	—	.03	.02	.05	.02	.12	.91	1.66
E.	—	.06	.08	.06	.01	—	.21	1.59	2.92
F.	—	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—	—
Total	.56	2.42	1.29	1.15	1.12	.64	7.18	54.56	100

Table LII.

N3. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.45	1.68	.57	.66	.53	.40	4.29	32.60	58.93
B.	.06	.28	.20	.25	.09	.19	1.07	8.13	14.70
C.	.09	.64	.38	.20	.21	.02	1.54	11.70	21.15
D.	—	—	—	.02	.04	.05	.11	.84	1.51
E.	—	.09	.11	.05	.01	—	.26	1.98	3.57
F.	—	—	—	—	—	—	—	—	—
G.	—	.01	—	—	—	—	.01	.08	.14
Total	.60	2.70	1.26	1.18	.88	.66	7.28	55.33	100

Table LIII.

N4. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.22	2.02	.74	.74	.79	.49	5.00	38.00	65.28
B.	.01	.26	.16	.20	.18	.23	1.04	7.90	13.57
C.	.04	.53	.23	.19	.23	.04	1.26	9.58	16.45
D.	—	—	.01	.01	.04	.01	.07	.53	.91
E.	—	.16	.09	.02	.01	.01	.29	2.20	3.79
F.	—	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—	—
Total	.27	2.97	1.23	1.16	1.25	.78	7.66	58.21	100

Table LIV.

N5. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.46	.72	1.74	.71	.67	.43	4.73	35.94	68.05
B.	.03	.17	.31	.23	.15	.19	1.08	8.21	15.53
C.	.04	.19	.38	.15	.15	—	.91	6.92	13.10
D.	—	—	—	.04	.06	—	.10	.76	1.44
E.	—	.07	.03	.01	—	—	.11	.84	1.59
F.	.02	—	—	—	—	—	.02	.15	.29
G.	—	—	—	—	—	—	—	—	—
Total	.55	1.15	2.46	1.14	1.03	.62	6.95	52.82	100

Table LV.

N6. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.64	1.92	.55	.52	.61	.26	4.50	34.21	66.18
B.	.03	.31	.22	.20	.15	.18	1.09	8.28	16.03
C.	.07	.38	.18	.12	.13	.02	.90	6.84	13.23
D.	—	—	.02	.02	.05	.03	.12	.91	1.76
E.	—	.09	.06	.01	.03	—	.19	1.44	2.80
F.	—	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—	—
Total	.74	2.70	1.03	.87	.97	.49	6.80	51.68	100

Table LVI.

N7. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.58	1.50	.64	.64	.60	.15	4.11	31.23	65.45
B.	.02	.20	.14	.18	.13	.13	.80	6.08	12.75
C.	.08	.56	.24	.20	.08	.03	1.19	9.04	18.94
D.	—	—	—	.03	.02	—	.05	.38	.79
E.	—	.06	.06	.01	—	—	.13	.99	2.07
F.	—	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—	—
Total	.68	2.32	1.08	1.06	.83	.31	6.28	47.72	100

Table LVII.

N8. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.48	1.52	.51	.76	.61	.27	4.15	31.54	62.68
B.	.02	.19	.19	.25	.16	.19	1.00	7.60	15.11
C.	.08	.51	.31	.19	.12	.03	1.24	9.42	18.74
D.	—	—	—	.03	.03	.03	.09	.68	1.36
E.	—	.07	.07	—	—	—	.14	1.06	2.11
F.	—	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—	—
Total	.58	2.29	1.08	1.23	.92	.52	6.62	50.30	100

Table LVIII.

O1. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.53	1.45	.51	.42	.76	.37	4.04	30.70	61.86
B.	.05	.30	.18	.13	.14	.21	1.01	7.68	15.48
C.	.10	.48	.31	.13	.06	.04	1.12	8.51	17.15
D.	—	—	—	.02	.04	.04	.10	.76	1.53
E.	—	.16	.08	—	—	—	.24	1.82	3.68
F.	—	—	—	—	—	—	—	—	—
G.	—	.02	—	—	—	—	.02	.15	.30
Total	.68	2.41	1.08	.70	1.00	.66	6.53	49.62	100

Table LIX.

02. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.45	1.51	.49	.54	.65	.22	3.86	29.33	63.48
B.	.02	.24	.16	.20	.19	.19	1.00	7.60	16.46
C.	.06	.35	.16	.09	.11	.01	.78	5.93	12.83
D.	—	—	—	.02	.03	.03	.08	.61	1.32
E.	—	.18	.08	.03	—	—	.29	2.20	4.76
F.	—	—	—	—	—	—	—	—	—
G.	—	.07	—	—	—	—	.07	.53	1.15
Total	.53	2.35	.89	.88	.98	.45	6.08	46.20	100

Table LX.

03. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.57	1.63	.41	.50	.44	.21	3.76	28.58	58.75
B.	.03	.34	.14	.18	.23	.13	1.05	7.98	16.42
C.	.08	.58	.21	.10	.16	—	1.13	8.59	17.66
D.	—	—	—	.04	.05	.05	.14	1.06	2.18
E.	—	.14	.08	.01	.01	—	.24	1.82	3.74
F.	—	—	—	—	—	—	—	—	—
G.	—	.08	—	—	—	—	.08	.61	1.25
Total	.68	2.77	.84	.83	.89	.39	6.40	48.64	100

Table LXI.

O4. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.34	2.06	.74	.76	.70	.33	4.93	37.48	68.03
B.	.01	.24	.15	.17	.18	.18	.93	7.05	12.79
C.	.06	.43	.24	.26	.08	.01	1.08	8.20	14.88
D.	—	—	—	.02	.02	.04	.08	.61	1.11
E.	—	.10	.06	—	—	—	.16	1.22	2.22
F.	—	—	—	—	—	—	—	—	—
G.	—	.04	.02	.01	—	—	.07	.53	.97
Total	.41	2.87	1.21	1.22	.98	.56	7.25	55.09	100

Table LXII.

O5. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.32	2.06	.63	.64	.62	.25	4.52	34.34	62.85
B.	.01	.25	.17	.26	.23	.21	1.13	8.58	15.70
C.	.06	.46	.27	.20	.18	.01	1.18	8.99	16.45
D.	—	.14	—	.04	.03	.04	.25	1.90	3.48
E.	—	—	.08	.01	—	—	.09	.68	1.25
F.	—	—	—	—	—	—	—	—	—
G.	—	.01	—	—	.01	—	.02	.15	.27
Total	.39	2.92	1.15	1.15	1.07	.51	7.19	54.64	100

Table LXIII.

O6. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.47	1.87	.47	.52	.61	.19	4.13	31.39	61.81
B.	.03	.27	.20	.21	.19	.16	1.06	8.06	15.89
C.	.04	.61	.21	.20	.06	—	1.12	8.51	16.76
D.	—	—	.01	.02	.03	.02	.08	.61	1.21
E.	—	.17	.06	.02	—	—	.25	1.90	3.74
F.	—	—	—	—	—	—	—	—	—
G.	—	.04	—	—	—	—	.04	.30	.59
Total	.54	2.96	.95	.97	.89	.37	6.68	50.77	100

Table LXIV.

O7. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.49	1.78	.40	.53	.51	.22	3.93	29.86	62.55
B.	.02	.20	.20	.24	.15	.19	1.00	7.60	15.91
C.	.08	.43	.20	.20	.10	.02	1.03	7.83	16.40
D.	—	.13	—	.02	.05	.07	.27	2.06	4.31
E.	—	—	.03	.01	—	—	.04	.30	.62
F.	—	—	—	—	—	—	—	—	—
G.	—	.01	—	—	—	—	.01	.08	.21
Total	.59	2.55	.83	1.00	.81	.50	6.28	47.73	100

Table LXV.

O8. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.50	1.73	.46	.57	.52	.32	4.10	31.16	61.84
B.	.02	.26	.16	.17	.18	.15	.94	7.14	14.17
C.	.09	.57	.20	.20	.10	.04	1.20	9.12	18.09
D.	—	—	—	.02	.05	.05	.12	.91	1.81
E.	—	.14	.06	—	—	.01	.21	1.60	3.18
F.	—	—	—	—	—	—	—	—	—
G.	—	.06	—	—	—	—	.06	.46	.91
Total	.61	2.76	.88	.96	.85	.57	6.63	50.39	100

Table LXVI.

P1. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.41	1.70	.48	.83	.45	.17	4.04	30.70	61.59
B.	.02	.22	.19	.21	.20	.16	1.00	7.60	15.25
C.	.12	.50	.29	.19	.10	.04	1.24	9.42	18.90
D.	—	.09	—	.01	.05	.05	.20	1.52	3.04
E.	—	—	.05	.02	—	—	.07	.53	1.06
F.	—	—	—	—	—	—	—	—	—
G.	—	—	—	.01	—	—	.01	.08	.16
Total	.55	2.51	1.01	1.27	.80	.42	6.56	49.85	100

Table LXVII.

P2. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.51	1.57	.54	.56	.37	.16	3.71	28.19	63.31
B.	.02	.22	.14	.17	.18	.15	.88	6.69	15.02
C.	.07	.49	.22	.13	.07	.02	1.00	7.60	17.06
D.	—	—	.01	.02	.03	.03	.09	.68	1.53
E.	—	.10	.05	.03	—	—	.18	1.37	3.08
F.	—	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—	—
Total	.60	2.38	.96	.91	.65	.36	5.86	44.53	100

Table LXVIII.

P3. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.48	1.55	.55	.65	.44	.23	3.90	29.64	62.21
B.	.04	.22	.20	.23	.17	.12	.98	7.45	15.63
C.	.08	.41	.33	.18	.07	.02	1.09	8.28	17.38
D.	—	—	—	.02	.06	.03	.11	.84	1.76
E.	—	.09	.06	.04	—	—	.19	1.44	3.02
F.	—	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—	—
Total	.60	2.27	1.14	1.12	.74	.40	6.27	47.65	100

Table LXIX.

P4. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.25	1.58	.66	.72	.54	.34	4.09	31.07	64.62
B.	.01	.21	.16	.22	.20	.15	.95	7.22	15.01
C.	.06	.36	.23	.24	.09	.03	1.01	7.68	15.96
D.	—	—	—	.03	.06	.04	.13	.99	2.05
E.	—	—	.09	.03	—	—	.12	.91	1.89
F.	—	.03	—	—	—	—	.03	.23	.47
G.	—	—	—	—	—	—	—	—	—
Total	.32	2.18	1.14	1.24	.89	.56	6.33	48.10	100

Table LXX.

P5. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.15	1.75	.62	.80	.53	.29	4.14	31.47	58.90
B.	.01	.23	.14	.25	.21	.15	.99	7.52	14.07
C.	.07	.38	.38	.31	.21	.04	1.39	10.56	19.77
D.	—	—	—	.01	.08	.09	.18	1.37	2.56
E.	—	.14	.13	.06	—	—	.33	2.51	4.70
F.	—	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—	—
Total	.23	2.50	1.27	1.43	1.03	.57	7.03	53.43	100

Table LXXI.

P6. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.22	2.05	.54	.68	.42	.26	4.17	31.69	59.99
B.	.01	.23	.18	.20	.22	.13	.97	7.37	13.97
C.	.07	.56	.40	.20	.10	.02	1.35	10.26	19.42
D.	—	—	—	.06	.05	.05	.16	1.22	2.31
E.	—	.14	.13	.01	—	—	.28	2.13	4.03
F.	—	—	—	—	—	—	—	—	—
G.	—	.02	—	—	—	—	.02	.15	.28
Total	.30	3.00	1.25	1.15	.79	.46	6.95	52.82	100

Table LXXII.

P7. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.25	1.86	.46	.76	.39	.31	4.03	30.64	60.49
B.	.02	.24	.16	.21	.19	.11	.93	7.07	13.97
C.	.07	.55	.36	.24	.07	.03	1.32	10.02	19.80
D.	—	—	—	.03	.03	.05	.11	.84	1.67
E.	—	.13	.06	.03	—	—	.22	1.67	3.31
F.	—	—	—	—	—	—	—	—	—
G.	—	.02	.01	.02	—	—	.05	.38	.76
Total	.34	2.80	1.05	1.29	.68	.50	6.66	50.62	100

Table LXXIII.

P8. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.26	1.70	.54	.56	.74	.14	3.94	29.94	58.56
B.	.01	.19	.18	.22	.29	.11	1.00	7.60	14.86
C.	.12	.48	.34	.25	.10	.04	1.33	10.11	19.77
D.	—	—	.02	.04	.06	.05	.17	1.29	2.52
E.	—	.18	.05	.02	—	—	.25	1.90	3.71
F.	—	—	—	—	—	—	—	—	—
G.	—	.01	.02	.01	—	—	.04	.30	.58
Total	.39	2.56	1.15	1.10	1.19	.34	6.73	51.14	100

Table LXXIV.

Q1. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.02	.46	.11	.21	.27	.22	1.29	9.80	29.38
B.	—	.06	.04	.12	.11	.10	.43	3.27	9.80
C.	.01	.36	.25	.06	.06	—	.74	5.62	16.85
D.	—	—	—	—	.06	.02	.08	.61	1.82
E.	—	.81	.54	.31	.18	—	1.84	13.98	41.91
F.	—	—	—	—	—	—	—	—	—
G.	—	—	.01	—	—	—	.01	.08	.24
Total	.03	1.69	.95	.70	.68	.34	4.39	33.36	100

Table LXXV.

Q2. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.01	.36	.20	.15	.22	.18	1.12	8.51	34.36
B.	—	.04	.04	.08	.08	.10	.34	2.58	10.42
C.	.01	.22	.18	.05	.08	—	.54	4.10	16.55
D.	—	—	—	—	.02	.03	.05	.38	1.52
E.	—	.35	.41	.28	.17	—	1.21	9.20	37.15
F.	—	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—	—
Total	.02	.97	.83	.56	.57	.31	3.26	24.77	100

Table LXXVI.

Q3. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	—	.29	.24	.14	.19	.28	1.14	8.66	32.02
B.	—	.06	.04	.06	.10	.07	.33	2.51	9.29
C.	.01	.29	.16	.06	.06	—	.58	4.41	16.30
D.	—	—	—	—	.02	.02	.04	.30	1.11
E.	—	.52	.41	.44	.10	—	1.47	11.17	41.28
F.	—	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—	—
Total	.01	1.16	.85	.70	.47	.37	3.56	27.05	100

Table LXXVII.

Q4. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	—	.67	.39	.22	.36	.34	1.98	15.05	30.10
B.	—	.06	.14	.05	.08	.14	.47	3.57	7.14
C.	.01	.51	.42	.38	.10	—	1.42	10.79	21.58
D.	—	—	—	.01	.02	.02	.05	.38	.76
E.	—	.94	.75	.72	.21	—	2.62	19.91	39.82
F.	—	—	—	—	—	—	—	—	—
G.	—	.04	—	—	—	—	.04	.30	.60
Total	.01	2.22	1.70	1.38	.77	.50	6.58	50.00	100

Table LXXVIII.

Q5. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	.02	.43	.39	.30	.25	.18	1.57	11.93	27.92
B.	—	.03	.15	.19	.07	.09	.53	4.03	9.45
C.	.01	.42	.25	.06	.14	—	.88	6.69	15.66
D.	—	—	—	—	.03	.02	.05	.38	.89
E.	—	.80	.82	.73	.22	—	2.57	19.53	45.73
F.	—	—	—	—	—	—	—	—	—
G.	—	.02	—	—	—	—	.02	.15	.35
Total	.03	1.70	1.61	1.28	.71	.29	5.62	42.71	100

Table LXXIX.

Q6. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	—	.21	.34	.16	.09	.07	.87	6.61	32.83
B.	—	.03	.06	.08	.05	.03	.25	1.90	9.43
C.	—	.09	.12	.06	.03	—	.30	2.28	11.32
D.	—	—	—	—	.02	—	.02	.15	.74
E.	—	.32	.38	.43	.08	—	1.21	9.20	45.68
F.	—	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—	—
Total	—	.65	.90	.73	.27	.10	2.65	20.14	100

Table LXXX.

Q7. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	—	.17	.32	.30	.14	.14	1.07	8.13	41.98
B.	—	.05	.05	.09	.05	.05	.29	2.20	11.36
C.	—	.02	.08	.07	.04	—	.21	1.60	8.26
D.	—	—	—	.01	.01	.03	.05	.38	1.96
E.	—	.20	.29	.40	.04	—	.93	7.06	36.44
F.	—	—	—	—	—	—	—	—	—
G.	—	—	—	—	—	—	—	—	—
Total	—	.44	.74	.87	.28	.22	2.55	19.37	100

Table LXXXI.

Q8. Variety—"Ailsa Craig."

Grade.	Lbs. per Plant.							Tons per Acre.	Per Cent. of Total.
	May.	June.	July.	Aug.	Sept.	Oct.	Total.	Total.	
A.	—	.50	.33	.19	.24	.17	1.43	10.87	38.05
B.	—	.08	.09	.11	.12	.07	.47	3.57	12.49
C.	—	.20	.20	.05	.03	—	.48	3.65	12.77
D.	—	—	—	—	.04	.03	.07	.53	1.85
E.	—	.50	.50	.24	.03	—	1.27	9.65	33.77
F.	.01	—	—	—	—	—	.01	.08	.27
G.	—	.03	—	—	—	—	.03	.23	.80
Total	.01	1.31	1.12	.59	.46	.27	3.76	28.58	100

Manurial Treatment of Series N, O, and P.

Base Manure.

1 lb. Lime
14 lbs. Stable Manure
¼ lb. Bone Meal
¼ lb. Bone Flour
¼ lb. Sulphate of Potash
} per sq. yd.

Top-dressing.

Mulch of Stable Manure.

Eight dressings, each consisting of 2 ozs. per sq. yd. of the following mixture:—

3 parts Sulphate of Ammonia.
2 parts Dried Blood.
7 parts 30% Superphosphate.
5 parts Pure Dissolved Bones.
½ part Bone Flour.
2½ parts Sulphate of Potash.

Cucumber Experiments.

The experiments, begun in 1922, with the object of discovering the nature of the depressing factor in cucumber bases and a method for its elimination have been continued. The base in House D, which showed an increase in crop of 35% after steaming in 1922, was left untouched in 1923 to see if the beneficial effect of steaming would persist in another season. The increase of 1922 did not persist in 1923 and indicated that the beneficial effect of steaming the base is felt during the year of treatment only and does not persist during the following season. In the winter, 1923-24, the base of this plot was again steamed, in an attempt to repeat the results after steaming in 1922. The result shown for this plot, D1 in Table LXXXII., shows a very slight increase in yield over the control plot and is rather disappointing, for it indicates that the beneficial effect of steaming may be neutralised by unsuitable weather conditions at the time the young crop is developing. After steaming the base in 1922 the weather was favourable to cucumber cultivation and the young plants were able to take full advantage of the steamed soil, so much so that the early pickings showed an increase of 50% over those of the control plot. The increase later fell to 35%. In 1924 the weather conditions were unfavourable for the cucumber crop and the first "breaks" did not develop normally. Steaming actually produced a retardation effect in the first pickings, which, however, was corrected later in the year.

As steaming the base produced an increased yield in 1922 it was considered that the application of manure prior to steaming might increase the yield still further; an experiment was arranged to test this in House C during 1924.

In two plots, C2 and C4, ½ cwt. of horse manure and ½ cwt. of cow manure was applied to each nine feet of border and dug in prior to steaming. Plots C1 and C3 were steamed without the application of manure. The results given in Table LXXXII. show an increase of 17% in favour of the manured and steamed base. In reality the increase is greater than this, because plots C2 and C3, being at the coldest end of the house, were badly affected by the low temperature and C3 was unable to take full advantage of the treatment.

The experiments with plants grown in beds over concrete in Houses D. and E. were continued. These experiments

were begun, because it was argued that if a depressing "factor" was present in the base a better crop should be obtained by covering the base with a layer of concrete, and so preventing the roots of the plants from coming into contact with it. In 1922 the yield from the plants in these beds was neither greater nor less than that of the control and it was thought that the beds were too small to allow unrestricted root production. In 1923 larger beds were made but still the yield approximated to that of the control. In 1924 a low concrete wall was placed from east to west across the concrete base, so as to divide it into two equal areas. A three-inch layer of soil from an old base was placed over the concrete of the south portion before introducing the beds, whilst the north portion was free from this and was sterilised by means of formaldehyde, and finally by burning the surface with a painter's blow lamp. The soil round the concrete was sterilised by steam, and beds were placed on the concrete. During the season care was taken to prevent, as far as possible, infection from being carried by the shoes of the worker from the floor of the house to the beds. The results given in Table LXXXII., plots D2, D3, E1 and E2 still throw no light on the problem.

Interesting results were obtained from an experiment conducted in House F. The beds used during 1923 were spread over the base and dug into it instead of being removed in the usual way. Plot F1 remained untreated, while plot F2 was steamed during the winter, 1923-24. No new soil was introduced into this house, the beds being prepared by bringing in stable manure and mixing it with the soil already in the house. The plants in both plots did equally well until the first week in July, when signs of flaccidity appeared in those on plot F1 where the soil had not been sterilised. This wilting became gradually worse until the last week in July, when the plants began to die. By the middle of August all the plants in plot F1 were dead, while those in plot F2, which had been sterilised, were green and healthy and remained so until the end of September. Results given in Table LXXXII. show a decrease of 28% in the case of the plot (F1) where the previous year's beds had been spread and used again without steaming. They also show an increase of 13% (F2) from the use of the previous year's beds, steamed before planting. In view of the fact that a border made up of new soil and manure (F3) gave a yield of 55·62 lbs. per plant, and that the old border soil (F2) after steaming it and adding dung gave 62·92 lbs. per plant,

Table LXXXII.

Plot.	Treatment.	Lbs. per Plant.							Total.	Tons per Acre.	Flats per Foot.	Relative Value	
		Mar.	April.	May.	June.	July.	Aug.	Sept.					
C1.	Base steamed	0.16	10.16	11.17	10.53	7.51	6.47	3.33	49.33	74.00	1.4	99	100
C3.	,, ,, ...	—	6.90	12.37	11.04	7.33	9.42	3.41	50.47	75.71	1.4	101	
C2.	Base steamed after digging in horse and cow manure (½ cwt. of each per 9 ft. of border)	—	6.13	18.00	10.57	7.28	8.24	5.13	55.35	83.03	1.6	110	117
C4.	,, ,, ,,	0.09	9.44	20.09	10.02	8.18	9.33	4.57	61.72	92.58	1.8	124	
D1.	Base steamed in 1922, untreated in 1923 and steamed again in 1924	1.54	11.61	11.82	12.75	8.64	7.81	3.00	57.17	85.76	1.6	103	
D2.	Base covered with layer of concrete sterilised before introducing the beds	2.84	7.58	8.15	11.01	9.53	6.70	2.60	48.41	72.62	1.4	87	87
E1.	,, ,, ,,	2.85	9.70	8.61	9.71	7.00	6.93	3.24	48.04	72.06	1.4	86	
D3.	Base covered with concrete layer infected with a three-inch layer of soil from an old base before introducing the beds	1.02	9.64	11.65	10.40	8.19	5.96	1.48	48.34	72.51	1.4	87	89
E2.	,, ,, ,,	1.92	11.09	10.40	9.64	8.32	7.39	1.94	50.70	76.05	1.5	91	
E3.	Control	1.87	10.90	10.01	10.17	10.27	9.90	2.50	55.62	83.43	1.6	100	
F1.	Last year's beds dug into the base and beds made up without introducing new soil	1.95	9.41	10.19	9.22	5.80	3.51	—	40.08	60.12	1.2	72	
F2.	As F1. but steamed before making up the beds	0.45	9.47	13.28	12.57	13.09	9.17	4.87	62.92	94.38	1.8	113	

the process of spreading the old cucumber beds at the end of the season and subsequently steaming before bringing in the manure for the next season's beds, becomes a process with economic possibilities. Future tests may show that where a steaming apparatus is available it may cost no more to spread and steam the old beds than to remove them at the end of the season and introduce new beds composted in the usual way. It is instructive to find that the highest yields in this series of experiments came from beds placed on a well-manured clean base.

Table LXXXIII.

Showing the composition of the beds, and the top-dressing treatment employed in the cucumber experiments in houses C, D, E and F.

Beds	Top-dressing		
	1st dressing March 4th	2nd dressing March 14th	Remaining dressings March 19th to September 12th
2 parts loam and 1 part stable manure composted in November	Small ring of cow manure round each plant	Loam and stable manure with 14lbs. bone meal to every 100 ft. of border	Loam and stable manure with 14 lbs. fertiliser as given in Tomato Series G., H. and M. to every 100 ft. of border

Soil Sterilisation Experiments.

The experiments conducted at Nurseries No. 1 and 2 since 1919 were discontinued. In the case of the latter, both houses were steamed, and records taken of the crop yield of each plot. The results are shown in the last column of Table LXXXIV. As in the case of previous years, sterilisation has not materially increased the yield.

Mr. C. H. Shoults very kindly placed another of his houses at our disposal, and it was possible to arrange a further trial of sterilising agents. A plan showing the arrangement of the plots in the houses is given in Fig. 1.

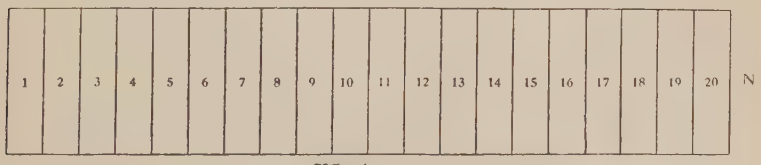


FIG 1

Table LXXXIV.

Soil Sterilisation Experiments. Nursery No. 2.

TREATMENT.	Plot No.	Total 1919.			1920.			1921.			1922.			1923.			1924.		
House A.		Lbs. per plant.	Tons pr acre.	Relative.	Lbs. per plant.	Tons pr acre.	Relative.	Lbs. per plant.	Tons pr acre.	Relative.	Lbs. per plant.	Tons pr acre.	Relative.	Lbs. per plant.	Tons pr acre.	Relative.	Lbs. per plant.	Tons pr acre.	Relative.
Untreated ...	3	5.29	42.3	99	4.90	39.2	103	4.56	36.5	103	4.59	36.7	103	4.23	33.8	98	4.37	34.96	100
Untreated ...	7	5.41	43.3	101 } 100	4.64	37.1	97 } 100	4.31	34.5	97 } 100	4.32	34.6	97 } 100	4.37	34.9	102 } 100	4.38	35.04	100 } 100
Carbolic	2	5.16	41.3	96	4.99	39.9	105	4.46	35.7	100	4.53	32.2	90	4.14	33.1	96	4.30	34.40	98
Carbolic	6	5.20	41.6	97 } 97	4.86	38.9	102 } 104	4.20	33.6	95 } 98	4.24	33.9	95 } 93	4.26	34.1	99 } 98	4.06	32.48	93 } 96
Steam	1	5.39	43.1	101	5.12	41.0	107	5.31	42.5	120	5.32	42.6	119	4.33	34.6	101	4.67	37.36	107
Steam	5	5.63	45.0	105 } 103	4.42	35.4	93 } 100	4.75	38.0	107 } 114	4.76	38.1	107 } 113	4.23	33.8	98 } 100	4.11	32.68	94 } 101
Hot Water ...	4	5.76	46.1	108	4.81	38.5	101	4.62	37.0	104	4.62	37.0	104	4.24	33.9	99	4.16	33.28	95
Hot Water ...	8	5.43	43.4	102 } 105	5.54	44.3	116 } 109	5.20	41.6	117 } 111	5.21	41.7	117 } 111	4.61	36.9	107 } 103	4.85	38.80	119 } 107
House B.																			
Untreated ...	1	5.47	43.8	97	5.21	41.7	108	5.03	40.2	105	5.02	40.2	106	4.87	38.9	105	5.12	40.96	106
Untreated ...	5	5.78	46.2	103 } 100	4.48	35.8	92 } 100	4.52	36.2	95 } 100	4.44	35.5	94 } 100	4.37	34.9	95 } 100	4.48	35.84	94 } 100
Carbolic	4	5.49	43.9	98	4.62	36.9	95	4.97	39.8	104	4.94	39.5	104	4.27	34.1	92	4.22	33.76	88
Carbolic	8	5.37	43.9	96 } 97	5.40	43.2	111 } 103	5.00	40.0	105 } 105	5.04	40.3	107 } 106	5.14	41.1	111 } 102	4.73	37.84	98 } 93
Steam	3	5.29	42.3	94	4.17	33.4	86	4.23	33.8	89	4.25	34.0	90	4.09	32.7	89	4.22	33.76	89
Steam	7	5.34	42.7	95 } 95	4.52	36.1	93 } 90	4.78	38.2	100 } 95	4.83	38.6	102 } 96	4.56	36.5	99 } 94	4.41	35.28	92 } 91
Hot Water ...	2	5.42	43.4	96	5.20	41.6	107	4.48	35.8	94	4.43	35.4	93	4.33	34.6	94	4.34	34.72	91
Hot Water ...	6	5.12	41.0	91 } 94	4.90	39.2	101 } 104	4.46	35.7	93 } 94	4.47	35.8	95 } 94	4.48	35.8	97 } 96	4.15	33.20	86 } 89

Table LXXXV.

Plot.	TREATMENT.	Lbs. per Plant.							Total Tons per Acre.	Relative.	
		June.	July.	Aug.	Sept.	Oct.	Nov.	Total.			
3	Control	0.62	2.06	0.72	0.70	0.36	0.26	4.72	37.76	99	100
9	Control	0.74	2.10	0.62	0.65	0.38	0.31	4.80	38.40	101	
16	Control	0.52	2.11	0.69	0.58	0.36	0.49	4.75	38.00	100	
4	Higher Phenols (quarter dose in water)	0.70	2.28	0.68	0.81	0.32	0.28	5.07	40.56	107	
2	Dichlorcresol (0.02% in water)	0.57	1.85	0.74	0.68	0.34	0.31	4.49	35.92	94	
5	Chlordinitrobenzene (0.002% in sand)	0.60	1.82	0.60	0.63	0.24	0.24	4.13	33.04	87	
6	,, (0.005% in sand)	0.77	1.99	0.75	0.66	0.34	0.19	4.70	37.60	99	
7	Cresylic acid (full dose in water)...	0.82	2.30	0.80	0.71	0.30	0.38	5.31	42.48	112	111
14	,, ,, (full dose in water)...	0.65	2.41	0.76	0.60	0.37	0.44	5.23	41.84	110	
10	Heavy oil (full dose in ashes)	0.62	2.05	0.61	0.68	0.33	0.34	4.63	37.04	97	
11	,, ,, (full dose in water)	0.77	2.47	0.62	0.72	0.38	0.47	5.43	43.44	114	
12	,, ,, (half dose in sand)	0.70	2.13	0.63	0.67	0.38	0.68	5.19	41.52	109	108
13	,, ,, (half dose in sand)	0.62	2.27	0.61	0.70	0.42	0.48	5.10	40.80	107	
15	,, ,, (half dose in water)	0.47	1.99	0.63	0.57	0.36	0.42	4.44	35.52	93	
18	,, ,, emulsified (half dose)	0.40	1.90	0.73	0.60	0.35	0.44	4.42	35.36	93	

The treatment, methods of application and yields are given in Table LXXXV. The beneficial effect of sterilisation is evident, the best results being obtained from cresylic acid and heavy oil in water.

By the kindness of Mr. J. Harnett it is possible to publish details of some instructive experiments conducted by him during 1924.

A block of houses, the soil of which had not been sterilised previously and in which tomatoes had been cultivated during twelve years, was set apart for this experiment.

The soil of fifteen houses was steamed by the grid method to a depth of eighteen inches; four houses were treated with 97 to 99% cresylic acid at the rate of 1 gallon over 9 sq. yds.; two houses were treated with certain other liquid soil sterilisers at the rate of 1 gallon over 22 sq. yds. as recommended; whilst two were left as controls.

It has long been realised that the difficulty of obtaining direct contact between chemical sterilisers and the finest particles of soil seriously affects their efficiency. Therefore in these experiments the application of such compounds to the soil was very carefully carried out. The method may be explained by reference to the application of cresylic acid.

One gallon of the acid (pale straw coloured, 97 to 99% purity) was placed in a tub containing about 40 gallons of water. An injector worked by water pressure was placed in the tub and the acid was gradually sucked out and watered on to the soil. Under the conditions of the experiment, approximately 89 gallons of water had passed through the injector by the time the tub was empty. Thus the acid was applied to the soil at a dilution of 1 in 129.

The soil to be treated was thoroughly broken up and then watered with the diluted acid. The tub was emptied over 18 sq. yds., and in the process the ground was covered twice. One man applied the acid while another followed behind and dug it into the soil. By this means the soil was treated and dug over twice. After an interval of eight or more days, to allow the soil to dry and become workable, the top spit of soil was turned upside down and a second application of acid, similar to the first, was made. It was considered that this method of application provided a better admixture of the acid with the soil than would usually occur in general practice.

On heavy soils, this method requires to be modified, as the quantity of water applied to a given area would be

excessive. A greater quantity of acid would have to be placed in the tub, which would be emptied over a larger area of soil.

The results of the various treatments are shown in Table LXXXVI.; they serve to illustrate the superiority of steaming over any other known method of sterilisation.

In view of results like this, it is surprising that small growers do not make more use of this method. Many growers think that a high-powered steam boiler is essential for steaming soil, but this is not so. Quite a small boiler of 10 or 12 horse power will be found suitable for small nurseries where the length of time taken is not a serious matter. Steam must be passed into the soil until the latter reaches a temperature of 200°F. some ten or twelve inches down; when this temperature is reached, another twenty minutes is sufficient. With a 30 horse power boiler the initial temperature will be reached after 20 to 30 minutes' steaming, but with a 12 horse power boiler a longer time is required.

Table LXXXVI.

Treatment.	Tons per Acre.	Relative.
Steam	50·25	180
Cresylic Acid	43	154
Other liquid soil sterilisers ...	33	114
Control	28	100

Mycological Investigations

Investigations during the past year have concerned a bacterial root disease of runner beans and a wilt disease of the cyclamen. The Director has continued his investigation of mosaic disease but some time must elapse before details can be published.

Diseases brought to the Station, not previously reported, are listed below.

Host.	Disease.	Parasite.
Aster	Wilt	*Fusarium sp.*
Bean	Bacterial disease of the root	*B. carotovorus*
Chrysanthemum	Powdery Mildew	*Erysiphe cichoracearum*
Chrysanthemum	Leaf spot	*Septoria chrysanthemella*
Cyclamen	Wilt	*Heterodera radicicola*
Lettuce	Rot	*Botrytis cinerea*
Mushroom		*Hypomyces perniciosus*
Rose	Leaf disease	*Mycosphaerella rosigena*
Strawberry	Leaf spot	*Mycosphaerella fragariae*
Tomato	Stem rot	*B. carotovorus*
Tomato	Nodules in roots	Cause unknown

A Bacterial Disease of the Roots of Runner Beans.

R. W. Butcher.

Symptoms.

This disease first appears some three or four weeks after sowing the seed. The first indication of its presence is the wilting of infected plants, which are generally stunted in habit and less vigorous than adjoining healthy plants. On removing a wilted plant from the soil, the stem, base and roots are seen to be brown in colour, the latter being easily detached on removing the soil. During the early stages of infection this discolouration is confined to a few sunken longitudinal streaks, varying from half-an-inch to one inch in length; later on, the entire stem base is involved. The surface becomes corky in nature and tends to crack and flake off. The lesions spread in an upward direction in the form of streaks which are reddish brown in colour.

Morbid Anatomy.

The characteristic feature of diseased plants is the browning and desiccation of the outer layers of the stem, whilst only in occasional specimens is there any browning of the pith. Transverse sections of the stem show the cortical cells of the

browned regions to be torn asunder. The cell-walls have collapsed and are thrown into folds, indicating a shrinkage and drying up of the diseased tissue. Bacteria may be seen in any of these collapsed cells but are most abundant in the inner-cortical cells. In the vascular cylinder, a few bacteria may be seen in both the phloem and xylem parenchyma but none has been demonstrated in the vessels.

The Causal Organism.

Two organisms were isolated by plating on potato agar pieces of the brown tissue removed aseptically from the pith of a diseased plant: a yellow bacillus and a white bacillus. These were tested for pathogenicity both singly and combined; positive results were obtained from inoculation with the white bacillus only.

This organism is a short rod 2–3.5 microns wide and 3–5 microns long existing singly and in pairs. It is motile, with 4–7 peritrichous flagellae and does not form spores. On culture media the behaviour is as follows:—

AGAR PLATE. Greyish white colonies evident after 24 hours; these are small, translucent, entire and raised.

AGAR SLOPE. Greyish white growth visible in 8 hours. It is scanty, translucent and entire, resembling that of *B. carotovorus*.

GELATINE STAB. Growth visible along the length of stab in three days. Growth crateriform and echinulate.

PEPTONE WATER + 2% GLUCOSE. Solution clouded in 24 hours. Vigorous growth with acid and gas produced in 24 hours. A Durham tube was completely filled with gas within 48 hours.

PEPTONE WATER + 2% LACTOSE. Solution cloudy in 24 hours. Acid and gas on the fifth day and then gas production vigorous.

PEPTONE WATER + 2% SACCHAROSE. Same reaction as for glucose.

PEPTONE WATER + 2% GLYCERINE. Solution clouded in 24 hours. No acid or gas up to 14 days.

USCHINSKY'S SOLUTION. Solution clouded in 24 hours. In two days a loose ring had formed. Solution bleached in three days. In seven days growth as an abundant, flocculent precipitate.

COHN'S SOLUTION. No growth in three weeks.

DUNHAM'S SOLUTION. Cloudy but no ring or pellicle in 24 hours. No Indol after six weeks. Growth in seven days as a fine abundant precipitate.

Bouillon + 1% nitrate. Cloudy in 24 hours. Nitrate present on the third day.

Bouillon + 1% mannite. Cloudy in 24 hours. Abundant gas production in 2 days.

Litmus milk. Very slightly acid on the fourth day. Same after four weeks.

Milk. Unchanged in four weeks.

Potato Plug. Growth apparent in 24 hours. In two days it was shining, raised, smooth and creamy. Tested on different vegetables it caused rot of mangold and turnip but did not rot the swede, potato, beet or carrot.

The above reactions seem in favour of this organism being regarded as a strain of *Bacillus carotovorus*, with a limited range of pathogenicity.

Inoculation Experiments.

Seeds of different kinds of beans were germinated in dishes in the incubator and some inoculated by pricking a small piece of a pure culture of the organism into the young root.

After twenty-four hours at 25°C. there was obvious browning round the inoculation point, in the case of runner beans and French beans and slight browning in the case of broad beans. Peas were not affected; controls also remained healthy. After seven days the browning had developed into streaks passing upwards in the stem cortex and in the vascular bundles. Broad beans, peas and all controls were unaffected.

The same varieties were grown in sterilised soil in pots and a proportion inoculated with a pure culture by pricks in the stem base. Runner beans and French beans showed typical disease symptoms after six weeks, while broad beans, peas and sweet peas remained healthy. All controls were healthy.

The effect of temperature on the progress of the disease.

To obtain some indication concerning the temperature most favourable to the disease, runner beans were planted in pots and inoculated; sets of six pots were then placed in different parts of the nursery, the temperature being recorded by thermometers placed close to the plants. Temperatures ranged from 64°F. to 85°F. While plants at the highest temperature showed little sign of disease, those at the lowest temperature became badly infected. Browning of the stem was visible fourteen to eighteen days earlier at the lowest temperature than at the highest temperature.

The effect of soil moisture on the progress of the disease.

Runner beans were planted in pots, inoculated and placed in a frame at an average temperature of 65°F. Varying quantities of water were given to different pots. After six weeks, plants receiving the heavier waterings were more badly diseased than those watered more judiciously.

The above inoculation tests indicate that relatively low temperatures coupled with too wet a soil provide the most suitable conditions for this disease. In attempting a control, the soil should be well aerated and drained and should be kept as warm as is possible without affecting the health of the crop. A light dressing of stable manure dug into the top layer of soil would appear to be advantageous.

Cyclamen Wilt Disease.

R. W. Butcher.

During the early part of 1924 a destructive disease of cyclamens was submitted from a nursery where many thousands of these plants are grown annually. Apparently it had existed at the nursery for several years, during which time much damage was done. During the season 1923 to 1924 it reached alarming proportions. On inquiry it appeared that the disease was by no means new to this country and that the annual losses caused by it were of a high order.

Symptoms of the disease.

The first signs of the disease in the glasshouses is the curling and wilting of the foliage of isolated plants. This generally commences in the oldest leaves, working rapidly into the centre until the entire foliage hangs limp and ultimately becomes desiccated. At this stage, most of the roots are brown and decaying, whilst the base of the corm shows signs of a soft rot. Later the centre of the corm becomes a black soft mass.

The corms first submitted to us for examination were mostly in an advanced state of disease, and the black rot teemed with nematodes. When any solid white tissue remained, the vascular strands were brown or reddish in colour and contained bacteria. A second batch of diseased corms showed brown and black rot at the corm base and bacterial infection in the vascular system. Some twenty isolations of the bacteria were made from diseased corms by removing pieces of discoloured bundles under aseptic conditions and plating on nutrient agar. With few exceptions, pure cultures of a bacillus were obtained. The exceptions gave a mixture of three organisms but the organism isolated from the other lesions

was constantly present. Inoculation of healthy corms with the various organisms yielded pathogenic results in the case of the dominant organism only; progress through the tissues was very slow, only a few millimetres of tissue being affected in two months. After a period of three to four months, the vascular systems of inoculated corms assumed a reddish brown colour.

The organism was readily re-isolated from affected bundles and found to be identical with that composing the inoculum.

Microscopic examination of the necrotic bundles showed the presence of bacteria only, but in the case of material taken from the base of the corm adjacent to the decayed portion, nematodes and bacteria were found in cortical cavities, usually surrounded by a corky layer.

A study of the morphological and physiological reactions of the organism isolated showed a close relation to *B. vulgatus* and *B. mesentericus*. Cultures of these organisms were obtained from the Lister Institute of Preventive Medicine and grown for comparison with the cyclamen organism. Table I. provides evidence of the similarity of the three organisms.

All three organisms were tested in respect of their ability to rot pieces of various vegetables. Inoculations were performed in sterile petri dishes, on vegetable cubes removed aseptically. The results are shown in Table II.

Inspection of Tables I. and II. emphasise the similarity between the cyclamen organism, *B. vulgatus* and *B. mesentericus*. Morphologically the three are identical. There are, however, small differences of growth. On cooked potato the cyclamen organism and *B. mesentericus* are less coarsely rugose than *B. vulgatus*. The cyclamen organism develops a pink tinge, *B. mesentericus* a brownish pink tinge and *B. vulgatus* a brown tinge. On potato and "jardox" agars the growth of *B. vulgatus* is more abundant than that of the two others. In all its growth reactions the cyclamen organism resembles *B. mesentericus* but its physiological reactions are stronger than those of the type organisms. It reduces nitrates, forms indol and rots slices of cyclamen corm and turnip and so differs from these organisms.

The identity and behaviour of the bacillus isolated from the necrotic bundles were not in favour of its being the primary cause of the disease and attention was directed to the nematode found in the decaying material at the base of the diseased corms. Inoculation experiments in progress while

Table I.

	B. vulgatus.	B. mesentericus.	Cyclamen Organism.
Size	0.5×2.0—3.0μ	0.5×1.5—3.0μ	0.5×2.0—3.0μ
Flagella	Peritrichiate	Peritrichiate	Peritrichiate
Spores	Central 0.5×1.2μ	Central 0.5×1.5μ	Central 0.5×1.5μ
Staining	Gram positive	Gram positive	Gram positive
Reactions	Stains well with methylene blue, fuchsin and gentian violet	Stains well with methylene blue, fuchsin and gentian violet	Stains well with methylene blue, fuchsin and gentian violet
Cooked Potato	Abundant, coarsely rugose, light brown...	Abundant, finely rugose, pink to brown	Abundant, finely rugose, pink
Gelatine (Beef)	Crateriform liquefaction in 7 days	Crateriform liquefaction in 7 days	Crateriform liquefaction in 7 days
Jardox Agar	Abundant, echinulate, wrinkled, cream	Thin, echinulate, wrinkled, cream	Thin, echinulate, wrinkled cream
Czapeks Agar	Scanty, beaded, wrinkled, cream	Scanty, beaded, wrinkled, cream	Scanty, beaded, wrinkled, cream
Potato Agar...	Abundant, echinulate, wrinkled, cream	Abundant, echinulate, wrinkled, cream	Abundant, echinulate, wrinkled, cream
Peptone+2% Dextrose ...	Acid produced on third day ..	Acid produced on third day ..	Acid produced on third day
,, +2% Lactose ...	Unchanged	Unchanged	Unchanged
,, +2% Saccharose..	Acid produced on third day ..	Acid produced on third day ..	Acid produced on third day
,, +2% Glycerine ...	Unchanged	Unchanged	Unchanged
Milk	Peptonised in seven days ...	Peptonised in seven days ...	Peptonised in seven days
Peptone+1% Nitrate ...	Nitrates not reduced... ...	Nitrates not reduced ...	Nitrates rapidly reduced
Uschinsky's Solution ...	Growth as a thin pellicle: solution bleached but remained clear	Growth as a very thin pellicle: solution remaining clear and coloured	Growth as an abundant pellicle : solution bleached
Dunham's Solution ...	Growth as a thin ring: solution remaining clear ...	Growth as a thin ring: solution remaining clear ...	Growth as a thin pellicle: solution remaining clear
Indol Production	None	None	Indol formed after four weeks
Diastatic Action	None	None	None

Table II.

Slices of Tissue.	B. vulgatus.	B. mesentericus.	Cyclamen Organism.
Carrot ...	No rot	No rot	No rot
Parsnip ...	,,	,,	Slight rot
Turnip ...	,,	,,	Rot complete in 7 days
Swede ...	,,	,,	No rot
Beet	,,	,,	,,
Potato ...	Rot complete in 7 days	Rot complete in 7 days	Rot complete in 7 days
Cyclamen corm ...	No rot	No rot	Rot complete in 7 days

the bacillus was under investigation provided no positive results, whether the nematodes were introduced into the corm or mixed with the soil; but this is not surprising in view of the known difficulty of inoculation by means of these animals.

Suitable potting soil was copiously infected with decayed corms teeming with nematodes, turned into pots and planted with healthy corms in February, 1924. Sets of these corms were examined monthly during the dormant season and no effect was noticed until the following August, when the corms were beginning to root and develop leaves. Examination of the corms showed the presence of large swellings on the under surface. These, on sectioning, were found to contain large numbers of nematodes in the centre of healthy tissue. No bacteria were found.

The nematode was identified as *Heterodera radicicola* by Dr. T. Goodey, to whom our best thanks are due.

Thus the primary cause of the disease would appear to be *Heterodera radicicola*, which is followed by an organism closely related to *B. mesentericus* and *B. vulgatus*. This latter organism spreads slowly through the vascular system of the corm, inducing a red colour in these regions.

Control.

It has been found in practice, that the best way of controlling this disease is by paying strict attention to house hygiene and thorough sterilisation of all infected materials. Diseased corms should be burned, pots and benches sterilised, glasshouses disinfected and all soil sterilised. The pots and soil are most conveniently sterilised by means of steam. Houses and benches may be washed down with formaldehyde or emulsified cresylic acid.

The hot water treatment of bulbs infected by eelworms has proved so satisfactory that it may be possible to devise similar methods for treating cyclamen corms, but until the details have been worked out the above methods of control should be adopted.

A Bacterial Rot of the Tomato Stem.

R. W. Butcher.

Towards the end of May, 1924, specimens of a decided stem rot were received for examination. Diseased stems varied from one half to three quarters of an inch in diameter and were bearing five trusses of fruit. The first sign of disease on the nursery was the falling over of the top of the plant and the consequent discovery of extensive internal rotting of the stem at the point of collapse. The pith of diseased plants was completely rotten for a distance of one to two feet at a point some four feet from the ground.

The causal organism was readily isolated in pure culture and identified as *Bacillus carotovorus*, the common cause of soft rot of vegetables.

The extreme virulence of the strain was its most remarkable feature but it was found to differ slightly from the type organism both in the slow rate at which it rotted the carrot and in its ability to rot the beet.

Inoculation Experiments.

(*a*) Small pieces of diseased pith were pricked into healthy plants.

Tobacco and Tomato. In 16 hours there was a distinct rotting of the pith and a browning of the vascular system three inches up the stem from the prick.

Cucumber. A slight rotting of the pith occurred in 24 hours and was very marked in 7 days.

(*b*) Healthy plants were inoculated by pricking into the stem small pieces of a pure culture of the organism.

Tomato Plants. Rot well advanced 16 hours after inoculation. In six days the plants collapsed.

Cucumber Fruits. A brown halo (about 1cm. in diameter) was visible around the prick after 24 hours.

Capsicum Plants. Stem rot commenced in 16 hours. In one week the plant collapsed, and around the prick only the skeleton of the vascular tissue remained.

Root of Radish. Rot visible in 3 hours. Complete rot in 16 hours.

Root of Turnip. (1 inch in diameter). Complete rot in 16 hours.

Root of Mangold. (1 inch cube). Complete rot in 16 hours.

Potato Tuber. (1 inch cube). Complete rot in 16 hours with a watery fluid on top.

Carrot. (1 inch cube). Only a slight rot in 4 days.

Lettuce Plants. Rot in 16 hours. Browning of vascular cylinder for 1 inch up stem.

Cabbage Stalks. Rot of pith in 16 hours.

Celery Plants. Base of seedlings rotted in 16 hours.

Onion Plants. No rot in 3 days.

Cyclamen Corm. Rapid rot visible in 16 hours. The corm became very soft and watery.

Arum Lily. No rot of petiole in 7 days.

The sudden appearance of this disease and its rapid progress through the plant caused considerable anxiety lest it should become epidemic. Every diseased plant was pulled up at sight and burned. All fallen leaves were collected and treated in the same way. Fortunately the disease ceased as suddenly as it had appeared and no further damage was done. No clue as to the mode of infection was obtained but it is possible the bacillus were pricked into the stem tissues by insects.

Soft Rot of the Arum.

W. F. Bewley.

This disease was described briefly in the Seventh Annual Report, 1921, and methods were suggested for its control. The process, which must be carried out at the end of the resting period, has been adopted on a large scale by growers with very satisfactory results. It includes the removal of diseased portions of the corms, thorough cleansing by scrubbing and immersion in a 2% solution of formaldehyde.

Our recommendations in 1921 stated that the corms should be dipped in formaldehyde during 4 hours but more recent work has shown that treatment during one hour is usually sufficient to destroy the bacteria (*Bacillus aroideae*) left on the corm after washing, etc.

The general method of treatment is as follows:—After the plants have been allowed to "dry off," they are shaken out of the pots and all soil removed. The adventitious roots are scraped off, all decayed parts cut out and the corms well scrubbed with water, using a fairly strong brush. The prepared corms are next steeped (taking care to keep as much of the foliage out of the liquid as possible) in a 2% solution of

formaldehyde (1 part 40% pure formaldehyde in 49 parts of water) during one hour. After this time they are removed and immediately potted up in disease-free soil in sterilised pots

A Survey of the Weeds found in the Lea Valley.

R. W. Butcher.

During 1924 a general survey of the weeds growing in the nurseries of the Lea Valley was made. About thirty nurseries were visited, the area covered being from Ponders End in the south to Hoddesdon in the north and Goff's Oak in the west to Waltham Abbey in the east. In addition, plants were carefully examined for their fungus pests.

The following is a list of the weeds found on all nurseries visited:—

1. *Anthriscus sylvestris*, Hoffm.
2. *Atriplex hastata*, L.
3. *Capsella Bursa-pastoris*, Med.
4. *Calystegia sepium*, Br.
5. *Cirsium arvense*, Scop.
6. *Convolvulus arvensis*, L.
7. *Epilobium montanum*, L.
8. *Hypochoeris radicata*, L.
9. *Lamium album*, L.
10. „ *purpureum*, L.
11. *Matricaria discoidea*, Dc.
12. „ *chamomilla*, L.
13. *Plantago major*, L.
14. „ *lanceolata*, L.
15. *Polygonum aviculare*, L.
16. *Potentilla reptans*, L.
17. *Ranunculus acris*, L.
18. „ *repens*, L.
19. „ *bulbosus*, L.
20. *Rumex obtusifolius*, L.
21. *Senecio vulgaris*, L.
22. *Solanum dulcamara*, L.
23. „ *nigrum*, L.
24. *Sonchus oleraceus*, L.
25. „ *asper*, Hill.
26. „ *arvensis*, L.
27. *Sisymbrium officinale*, L.
28. *Stellaria media*, Vill.
29. *Taraxacum officinale*, Weber.
30. *Trifolium pratense*, L.
31. „ *repens*, L.
32. *Urtica dioica*, L.

In addition to these there are a number of grasses that make up the pasture-land surrounding the glasshouses. The following were observed but this is probably not a complete list.

Agropyron repens, Bear.
Agrostis vulgaris, With.
Alopecurus pratensis, L.
Anthoxanthum odoratum, L.
Arrhenatherum elatius, M. & K.
Bromus mollis, L.
„ *asper*, L.
Dactylis glomerata, L.
Festuca pratensis, Huds.
Festuca bromides, L.
Holcus lanatus, L.
Hordeum murinum, L.
Lolium perenne
Phleum pratense, L.
Poa annua, L.
„ *trivialis*, L.
„ *pratensis*, L.

The next list contains plants that may be considered well distributed but were absent from some of the nurseries :—

Achillea millefolium, L.
Brassica arvensis, O. Kuntze.
Bryonia dioica, Jacq.
Cerastium vulgatum, L.
Cirsium lanceolatum, Sap.
Epilobium angustifolium, L.
Euphorbia Peplis, L.
Galium Aparine, L.
Heracleum Sphondylium, L.
Lapsana communis, L.
Leontodon autumnale, L.
Lotus corniculatus, L.
Malva sylvestris, L.
Matricaria inodora, L.
Papaver Rhoeas, L.
Polygonum persicaria, L.
Rumex crispus, L.
Sambucus nigra, L. (as seedlings).
Senecio Jacobea, L.
Trifolium dubium, Sibth.
Urtica urens, L.
Veronica Tournefortii, Gmel.
,, *Chamaedrys*, L.

Although most of the above have an irregular distribution the following facts are of interest. *Epilobium angustifolium* and *Matricaria inodora* are absent from the Hoddesdon district and abundant elsewhere, while *Papaver Rhoeas* and *Brassica arvensis* are not found on the nurseries on the higher ground at Flamstead End.

The remaining plants to consider are of more interest as many show a definite distribution into three districts, viz. : — (1) The low-lying nurseries by the side of the railway and the river ; (2) the nurseries at Flamstead End lying to the west and on higher land ; (3) the nurseries at Hoddesdon that are on a gravel soil.

The following completes the list of plants found and also indicates their distribution.

Aegopodium podograria, L. ... Rare. Seen on two nurseries.
Alchemilla arvensis, Scop. ... Common at Hoddesdon only.
Alopecurus agrestis, L. ... Rare. Seen on two nurseries.
Anagallis arvensis, L. ... Not uncommon and irregularly distributed.
Anthemis cotula, L. ... ... Rare. Seen on two nurseries.
Artemisia vulgaris, L. ... Common on the low lying nurseries.
Arctium Lappa, L. ... ... Not uncommon and irregularly distributed.
Avena sativa, L. ... ... Not uncommon around dung heaps.
Barbarea vulgaris, Ait. ... Common near Cheshunt Station
Ballota nigra, L. ... ... Common at Flamstead End.
Carex hirta, L. ... ... Rare. Once seen.
Caucalis Anthriscus, Huds. ... Rare. Irregularly distributed.

Centaurea nigra, L. ... ... Not uncommon and irregularly distributed.
„ *cyanus*, L. ... ... Rare. Seen only once.
Chenopodium rubrum, L. ... Common at Hoddesdon.
„ *polyspermum*, L. Not uncommon and chiefly in the higher land.
Chyrsanthemum leucanthemum, L. ... Not uncommon and irregularly distributed.
Cochlearia Armoracia, L. ... Abundant in nurseries near the railway.
Conium maculatum, L. ... Rare. Seen once at Hoddesdon.
Crepis taraxacifolia, Thuill ... Common at Hoddesdon. Rare elsewhere.
„ *capillaris*, Wallr. ... Not uncommon and irregularly distributed.
Epilobium hirsutum, L. ... Common in boundary ditches, etc.
„ *roseum*, Schreb. ... Rare. Seen on one nursery.
„ *parviflorum*, Schreb. Rare. Seen on one nursery.
Erysimum Chieranthoides, L. Seen only at Flamstead End.
Euphorbia Helioscopia, L. ... Uncommon and irregularly distributed.
Equisetum arvense, L. ... Rare. On land near the railway.
Fumaria officinalis, L. ... Occasional. No definite distribution.
Galeopsis tetrahit, L. ... ... Common at Flamstead End.
Galium verum, L. ... ... Rare and irregularly distributed
Geranium dissectum, L. ... Not uncommon and irregularly distributed.
„ *molle*, L. ... ... Not uncommon and irregularly distributed.
„ *Robertianum*, L. ... Not uncommon and irregularly distributed.
Hypericum perforatum, L. ... Casual. Seen once.
Iris Pseudacorus, L. ... ... Rare. In boundary ditch.
Lathyrus pratensis, L. ... Not uncommon and irregularly distributed.
Lepidium ruderale, L. ... On ground near the railway.
„ *Draba* ... ... Irregularly distributed mostly near ash paths.
Linaria vulgaris, Mill. ... Common near the railway.
Lotus corniculatus, L. ... Not seen at Flamstead End—common elsewhere.
Lychnis alba, Mill. ... ... Seen only in low-lying nurseries.
„ *dioica*, L. ... ... Rare. Irregular distribution.
Lythrum salicaria, L. ... ... Seen once on site of an old pond.
Malva rotundifolia, L. ... Not uncommon and irregularly distributed.

Medicago lupulina, L.... ... Not uncommon and irregularly distributed.
„ *sativa* ... ... A relic of former agricultural crops.
„ *denticulata*, Willd.... Two plants seen.
„ *orbiculata*, L. ... One plant seen.
Melilotus alba, Desr. ... ... Casual at Hoddesdon.
„ *officinalis*, Lan. ... Seen on the higher nurseries only.
„ *indica*, All. ... ... Not uncommon and irregularly distributed.
Nepeta hederacea, Trev. ... Common at Flamstead End.
Oenothera biennis, L.... ... Rare. Seen near the railway twice.
Aethusa cynapium, L. ... Not uncommon and irregularly distributed.
Oxalis stricta, L. ... ... Casual. Seen on one nursery.
Papaver dubium, L. ... ... Rare. Seen only once.
Phalaris arundinacea, L. ... Rare. Seen on two nurseries.
Pimpinella saxifraga, L. ... Rare. Irregularly distributed.
Polygonum Convolvulus, L. ... Not uncommon and chiefly on the higher land.
Pulicaria dysenterica, Gray ... Common on one nursery at Flamstead End.
Radicula palustris, Moench.... Common where there is a ditch.
„ *sylvestris*, Druce ... Common at Flamstead End.
Ranunculus arvensis, L. ... Casual in two nurseries.
Raphanus Raphanistrum, L. Rare. Irregular distribution.
Reseda lutea, L. ... ... Abundant at Hoddesdon, absent elsewhere.
Rumex acetosa, L. ... ... Common in pasture.
„ *acetosella*, L. ... ... Uncommon and irregularly distributed.
Scrophularia nodosa, L. ... Rare. Only twice seen.
Silaus flavescens, Bernh. ... Rare. Seen only on one nursery.
Sisymbrium Alliaria, Scoh. ... Common in the low-lying nurseries.
„ *pannonicum*, Joeq. Near the new road only.
„ *Sophia*, L. ... Abundant at Hoddesdon.
Thlaspi arvense, L. ... ... Mostly on the higher land.
Tragopogon minus, Mill. ... Not uncommon and irregularly distributed.
Trifolium hybridum, L. ... Rare. Relic of former crops.
„ *arvense*. L.... ... Common at Hoddesdon. Absent elsewhere.
Triticum vulgare, L. ... ... Not uncommon around dung heaps.
Veronica agrestis, L. ... ... Rare. Only twice seen.

Vicia Cracca, L. ...	... Not uncommon and irregularly distributed.
„ *hirsuta*, Gray ...	... Casual. Seen once at Ponders End.
„ *sativa*, L. ...	... Not uncommon and irregularly distributed.
„ *sepium*, L. ...	... Not uncommon and irregularly distributed.
Viola arvensis, L. ...	... Rare. Irregular distribution.

From the above list it may be seen that there is a marked difference between the weed flora of the Hoddesdon district, and that of the other districts examined. *Sisymbrium Sophia*, *Chenopodium rubrum* and other plants are common there and absent elsewhere. The difference between the other two districts also shows well, but the characteristic plants are not so marked. Other plants, such as *Lepidium ruderale*, *Cochlearia Armoracia*, and *Oenothera biennis*, are only recorded from nurseries near the railways, and may owe their origin to having been brought by ballast. Other weeds, such as *Scrophularia nodosa*, and *Lythrum salicaria*, clearly owe their origin to the dykes and ponds existing on the nurseries. *Sisymbrium pannonicum* and *Lolium italicum* were found in the nurseries near the newly-constructed arterial road, where these two plants are abundant. The common cereal plants are frequently found near dung heaps.

Nature of the Weeds.

Most of the weeds above mentioned may be considered comparatively innocuous but there are a few that deserve special mention.

Lepidium Draba: This weed has caused a lot of trouble in arable land of the east of England. It grows in large patches allowing nothing else to grow with it, and consequently takes up much valuable room that should be occupied by the crop. The weed reproduces freely (one plant will produce about 1,500 seeds) and it is also perennial with a creeping stem. It is, therefore, difficult of eradication. It is improbable that this will prove a pest to glasshouse culture but it may cause trouble in seed-beds of other plants. Its distribution at present in the Lea Valley is chiefly in the nurseries near the railway.

There are other weeds also that may cause trouble if allowed to become too abundant. Most important of these are the various docks (*Rumex*) with coarse growth and deep roots, the burdock (*Arctium Lappa*) with its hooked fruits and very large plants, and the thistles.

Fungus Diseases of the Weeds.

Particular attention was paid to the fungus parasites on the weeds gathered. The following parasitic fungi were observed :—

Fungus.	Host.
Cladosporium herbarum ...	*Agropyron repens.*
Coleosporium sp.	*Sonchus oleraceus.*
Cystopus candidus	*Capsella bursa-pastoris.*
Erisyphe chicoraceareum ...	*Sonchus oleraceus.*
„ *polygoni*	*Polygonum aviculare.*
„ „	*Plantago major.*
„ *umbelliferarum* ...	*Heracleum Sphondylium.*
Uromyces ficariae	*Cirsium arvense.*
Peronospora effusa	*Atriplex hastata.*
Puccinia poarum	*Tussilago farfara.*
„ *obtegens*	*Cirsium arvense.*
„ *malvacearum* ...	*Malva sylvestris.*
Synchytrium taraxaci	*Taraxacum officinale.*

This list is not a long one and the weeds appeared to be remarkably free from any fungus pests. It is well-known, however, that weeds serve as carriers of plant diseases and it may be well to point out the most suspicious varieties.

Solanum dulcamara and *Solanum nigrum* are two common weeds most likely to suffer from the same disease as the tomato plant. The former grows in all the hedges round the nurseries and frequently up the sides of the houses themselves.

Solanum nigrum is even commoner than *Solanum dulcamara* and is frequently found in the soil of the houses and on any bare or cultivated ground in the district. Under the sides of the glasshouses plants are frequent. *Bryonia dioica* is closely related to the cucumber and special attention was paid to this plant, but although in some cases there was a suggestion of a mottled leaf, cross inoculation experiments were negative. The plant grows in most of the boundary hedges of the nurseries.

Malva sylvestris is frequently infected with *Puccinia Malvacearum*, the hollyhock rust. Cross inoculation experiments from this plant to the hollyhock were unsuccessful, but it is stated by several workers that the fungus on them is identical.

During 1923 the cause of an epidemic of chrysanthemum rust on one nursery was traced to this fungus growing on thistles near the chrysanthemum bed. In addition to thistles, several others of this family may act as carriers of this particular disease, for instance, the ox-eye daisy (*Chrysanthemum leucathemum*), which is abundant on many nurseries.

On several nurseries, a large number of small tomato plants grew as weeds along the sides of the houses and sometimes on other parts of the nursery. These again were carefully examined for any sign of disease and none was found.

Entomological Investigations.

E. R. Speyer.

Red Spider *(Tetranychus telarius L.)*.

Notes on the Life and Seasonal History.

With a view to obtaining some definite information as to the possibility of Red Spider being able to pass the winter in the ground, a large number of cucumber leaves infested with red hibernating forms were placed on moist soil in jars and kept from December until March. The contents of the jars were then placed round the base of pot-plants. No infestation of the plants ensued and it would seem that the spider is not liable to be carried into glasshouses from outside in potting and border soil. The habits of hibernating spider are curious ; they will pass the winter in an exposed and active state on banana and carnation plants, where a few which have not assumed a red colour will lay eggs even at comparatively low temperatures. The red forms will not lay eggs during the winter even at comparatively high temperatures. On the plants mentioned, the eggs will hatch and maturity be reached, though development is slow.

If suitable plant life is lacking, the red forms congregate in crevices such as door-locks and especially in bamboo canes. Canes are often perforated by holes less than $\frac{1}{8}$ inch diameter made by a boring beetle shortly after they are cut from the plants in their country of origin. An examination revealed, in many cases, the presence of large numbers of spider which had crept through the holes into the hollow cane. It is thus practically certain that red spider seek out enclosed spaces with a narrow entrance in which to hibernate. Here it is not impossible that they should obtain some nourishment from lower forms of plant life, and fumes of cresylic acid in themselves not concentrated enough to kill the spider, might serve to remove this food-supply and lead indirectly to their death.

Regular breeding began in January on *Salvia* and *Datura* plants (under glass), the first generation resulting almost entirely in red forms which laid no eggs. On banana plants, egg-laying did not start till March, and after a few generations the spider began to leave the plants, hardly any remaining in June. At this time, when the infestation was intense in cucumber and tomato houses, legumes, such as beans and clover were the only other plants found to be badly attacked.

It has been suggested that spider breeds to a great extent on elm trees but except for a few individuals found on elm in hedgerows, only a bright red leaf-fungus was present, which might casually be mistaken for spider. No explanation of the widespread and serious attack on tomato-plants can be offered. Some attribute it to high winds, others to seasonal conditions. At the beginning of several attacks in tomato houses, a very large proportion of male spider was present ; as this indicates development from unfertilised eggs, it is probable that infection started from isolated females which had obtained access to the houses through ventilators.

Once again red spider collected from cucumber, tomato and carnation plants respectively have been compared by an authority on systematic entomology, who pronounces them to be identical.

In conjunction with fumigation experiments, it was found necessary to make close observations upon the length of time required for the various stages during development, with the following results for high temperature :—

Egg	5-6 days
Larva	2 ,,
Protonymph	2 ,,
Deutonymph	2 ,,
Adult prior to egg-laying	1 ,,

These periods apply to the female sex and correspond with similar observations recorded by American authors.

Some time has been devoted to a study of the internal anatomy of the spider. Practically nothing is known of this and great difficulties attend the technical aspect of such research. Some light has been thrown upon the breathing apparatus, which consists of branching tracheal tubes opening by a minute pair of orifices situated close together on either side of the dorsal median line of the cephalo-thorax.

A pair of conspicuous tube-like processes which were thought to be air reservoirs, are now interpreted as solid structures, which may act like springs for the opening and closing of the breathing apertures.

Experiments in Control by Naphthalene Fumigation.

The effect of pure white-flake naphthalene upon spider in small closed dishes was first observed. At low temperatures the action was very slow but in a hot-house or incubator above 70° F. the spider moved actively and in 15 minutes showed signs of great irritation ; in less than 39 minutes movement ceased. At high temperatures an exposure of 4 hours sufficed to kill them.

Three-litre jars were next used, leaves infected with spider being hung within the neck of the jar which was left open. One-half gramme of pure naphthalene was scattered on the floor of the jar, which stood overnight upon the pipes of a heated cucumber house. After 16 hours' exposure the spider were dead, except in one instance, when a single spider recovered after 22 hours' exposure. Similar results were obtained with camphor, camphene, menthol and thymol, which, like naphthalene, volatilise at comparatively low temperatures. Except naphthalene, these substances are too expensive for commercial use ; some are very injurious to plants and none has a marked advantage over naphthalene in killing spider.

Infected cucumber pot-plants were now placed in glass tanks of 1½ cubic feet capacity, together with 1 gramme pure naphthalene in a watch-glass, each tank being covered with a sheet of glass. At a temperature falling from 78° F. to 68° F., 50% of the spider recovered after 16 hours' exposure. On the other hand, at a mean temperature of 78° F. (max. 82° F., min. 74° F.) none recovered after a similar exposure. In the latter experiment, it was noted that many spider let themselves drop from the leaves on a web shortly after the vessel was closed ; at 6 hours they became motionless but when removed at this time all recovered within 17 hours' exposure to fresh air.

At temperatures ranging from 72° F. to 94° F., no spider recovered after 24 hours' exposure ; at the end of 40 hours the plants were removed and showed no sign of injury. The eggs of the spider were kept under close observation with untreated controls. The treated eggs were of a redder colour than the untreated ; none hatched subsequently against the 100% hatching of the control.

These results were of great importance in the investigation, as they showed for the first time that spider could be killed by a fumigant without injury to the plant and they gave a clue to the minimum temperature at which naphthalene vapour is effective in killing red spider.

Under similar conditions of experiment, a sample of crude naphthalene and some creosote samples containing naphthalene gave similar results, except that even small percentages of phenols or tar acids contained in them produced not only a scorching of leaves in brown patches but a general drooping of the plant. Scorching of the leaves of a cucumber pot-plant was produced with pure naphthalene, when the latter was heated to 194° F. for a few minutes in the tank. At 21 hours' exposure the spider had been killed, the lower leaves of the plant showing light patches between the veins. On removal to fresh but dry air and exposure to sunlight, a curling and browning of the leaf edges ensued, with a

whitening and final drying of the original scorched patches ; the top-most leaves and growing point were unaffected and the plant did not droop.

The conclusions from our preliminary experiments were as follows :—

(1) At a temperature above 74° F. all stages of red spider can be killed with naphthalene vapour, within a period of 40 hours, without injury to cucumber plants in pots.

(2) Scorching of leaves can be produced by too rapid an evaporation of naphthalene in an enclosed space. The effects are aggravated by exposure of the plant to a dry atmosphere.

(3) The presence of phenols or tar acids in crude naphthalenes and creosotes may produce scorching of a different and more serious nature than that due to pure naphthalene, without increasing the effectiveness of naphthalene vapour in killing red spider.

Experiments on Cucumber Plants in the border with graded naphthalene.

In a cucumber house 36 ft. long by 14 ft. wide with two borders, containing plants in fruit, 2 lbs. of pure commercial white-flake naphthalene which had been passed through a sieve of $\frac{1}{4}$ inch mesh, was broadcasted on each border at 4.0 p.m. After 21 hours with closed ventilators, a large number of leaves infected with spider were removed and watched ; only one spider recovered subsequently. After 24 hours, another 4 lbs. of naphthalene was applied. The naphthalene had not all volatilised until the sixth day from the start of the experiment, when no living spider or eggs could be found in the house. It was estimated that about 6,000 spider had been killed on some individual leaves. The temperatures ranged between 70° F. and 110° F. No leaves were actually scorched but the plants had a general yellow appearance, from which they took long to recover. The fumigation was carried out on June 5th and a second treatment was not found necessary until July 8th, although spider invaded the cucumbers a fortnight after the first treatment from some heavily infested bean plants growing outside a door of the house.

In a house 78 ft. long by 14 ft. broad, 8 lbs. of pure commercial white-flake naphthalene, which had been passed through a sieve of $\frac{1}{8}$ inch mesh, was broadcasted on the borders, as in the previous experiment.

After 18 hours with closed ventilators large numbers of spider in all stages of development were removed ; of them only 2 showed some sign of movement after $3\frac{1}{2}$ hours in fresh air but they died subsequently. After 24 hours, it was apparent that all the spider, including the eggs and resting stages had been killed.

The temperature fell to 73° F. at night and rose to 96° F. in the daytime. In 42 hours the naphthalene vapour had practically disappeared from the house. The leaves of the plants, generally, had what may be described as a brownish appearance but were far less affected than in the previous experiment. After ventilation and feeding, the plants became normal within a few days. Leaves from the plants were kept under observation for 4 days after the termination of the treatment. No eggs were observed to hatch and no spider recovered.

A week after fumigation, a few spider, all adults, were found on leaves immediately beneath the ventilators; undoubtedly they had gained access from outside.

This fumigation was carried out on June 11th; a second was not found necessary until July 9th. A third fumigation took place on August 8th.

Seeing that subdivision of the flake naphthalene tended to produce quicker effects with less injury to the plant, finely powdered naphthalene was next used, both at the experimental station and on a nursery.

The results were most unsatisfactory, and it became evident that there is a critical point of subdivision below which vaporisation is retarded instead of accelerated. The vaporisation of various grades on a small scale tended to show that the surface exposed to the air and absorption of moisture from the air are two important factors. Naphthalene in too fine a state of division is apt to "clog." By experiment it was determined that maximum efficiency is obtained by the use of white flake naphthalene which had been rubbed through a sieve of 1/16th inch mesh. For this purpose a glistening white and dry flake is desirable, whereby the chances of powdering when passing the sieve are reduced to a minimum. Any naphthalene of a yellowish tint is strictly to be avoided.

The naphthalene just described is now known as Pure Commercial White Flake Naphthalene, Grade 16.

With this, broadcasted over the border at the rate of 6 lbs. to a house 100 ft. by 14 ft. (3 lbs. to each border), a block of three cucumber houses was treated on June 23rd, at 5.0 p.m. The temperature was 96° F., with the soil surface at 90° F.

At 10.0 a.m. on June 24th the ventilators were opened for a short time, and the plants well damped overhead: temperatures—atmosphere 95° F. (max. 97°, min. 75°), soil surface 88° F. (max. 91°, min. 76°). Spider removed on leaves to fresh air at this time showed no movement and did not recover.

At 5.0 p.m. the vapour was still highly irritating and spider again removed did not recover. Damping overhead was repeated : temperatures—atmosphere 97° F. (max. 102°, min. 94°), soil surface 90° F. (max. 96°, min. 85°). On June 25th at 10.15 a.m. the vapours had dispersed : temperatures—atmosphere 90° F. (max. 98°, min. 75°), soil surface 84° F. (max. 93°, min. 85°). On June 25th at 10.15 a.m. the vapours had dispersed : temperatures—atmosphere 90° F. (max. 98°, min. 75°), soil surface 84° F. (max. 93°, min. 73°). Leaves were taken from all situations in the houses and kept under close observation during 6 days after termination of the experiment; all the spider with their eggs had been definitely killed.

The plants were quite uninjured and no further treatment was necessary until the end of August. Subsequent fumigations of all the cucumber houses at the experimental station on the lines indicated by this experiment were attended with most successful results.

Treatment of Cucumber Houses on Nurseries.

At the end of June, the results obtained by naphthalene fumigation had been so promising that a recommendation was submitted to growers asking them to give trial to the treatment on their nurseries. A ready response was shown, the outcome of which led to much valuable information being collected.

This information cannot be given in detail as the total area of houses treated exceeded 5 acres of glass, of which some 80 houses, representing 4 acres, were fumigated under the personal supervision of the entomologist. The general effects of naphthalene vapour upon the plants and upon red spider were noted and are set down in the following paragraphs.

Effect of Naphthalene vapour upon the Cucumber Plant.

(1) Effect upon the Leaf.

From the outset it was apparent that cucumber plants could not be treated with naphthalene vapour under all conditions, without some injury. Repeated experiments have shown that pot-plants insufficiently watered are highly liable to leaf-scorch whilst others with moist roots standing beside them have been entirely unaffected. The leaves were most injured when, during treatment, the ventilators were kept open after damping, this causing the leaf edges to curl and light patches to appear, especially upon the lower leaves of the plant.

A similar type of damage occurs when the plants have a bad root action, especially at the end of cropping; leaves which should have been removed in the process of trimming nearly always die during or shortly after fumigation.

Young plants, shortly after being put in the border, have shown small scorch marks on the 2nd and 3rd leaves from the base of each plant and on no others throughout a large house ; in general, however, young plants seem much less liable to scorching than old. This type of scorch can be produced in the course of less than one hour by dusting leaves with finely powdered naphthalene, if the atmosphere be at a high temperature. It is concluded that lack of moisture in the atmosphere and at the root of the plant is the most important factor in producing injury of this type ; naphthalene, being insoluble in water, is least liable to enter leaf-pores when the plants are giving out and not taking in moisture. A sudden drop in temperature might cause condensation of naphthalene upon leaves but it is doubtful if this ever actually occurred in cases where there was scorching ; further, a general condensation would tend to produce universal injury, whereas the foliage near the growing point practically never showed any ill effect, even in the worst cases.

A second type of injury is manifested by a general yellowing of the foliage ; when slight, this gives a general brownish appearance to the plants. This has been observed at its worst when houses have been treated after long periods of dull weather and in one case was attributed to weakness caused by bad root action from an attack of club-root. It is also pronounced when plants are exposed to comparatively small concentrations of vapour over a long period of time. No doubt a slight yellowing may take place under all conditions but it is soon remedied by ventilation and feeding. Bad cases are, however, very obstinate, and the plants take many weeks to become normal.

At present we can assign no actual cause to this condition.

(2) Effect on the Flower.

In no case has any injury to the flower of the cucumber plant been observed, even where plants have been exposed to such a concentration of vapour as to produce the most severe scorching of the foliage. In houses very badly infested with red spider before treatment, plants have put out quantities of male flowers shortly after fumigation—a sure sign of renewed vigour due to removal of the spider.

(3) Effect on the Fruit.

Naphthalene vapour is absorbed by ripening fruit on the cucumber plant. It was thought at first that this would preclude the use of naphthalene altogether for fumigating purposes. Fortunately, however, it was found that the taste imparted to the fruit quickly diminished on exposure to fresh air, and finally disappeared. Fruit hanging upon the plants in a high temperature

lose the taste more rapidly than at a low temperature. After 48 hours' fumigation, cucumbers which tasted strongly of naphthalene were exposed to fresh air for a period of 4 hours ; the taste was then barely recognisable by a very delicate palate.

(4) General effect of Fumigation on Red Spider.

When growers were fumigating their houses with naphthalene, a point was made of taking leaves from the plants immediately after treatment and keeping them under observation for at least four days.

When the following conditions were fulfilled, all stages of the spider were definitely killed within 24 hours from the beginning of the fumigation :—

(*a*) That the temperature remained above 74° F.

(*b*) That the naphthalene was well distributed over the borders.

(*c*) That the houses were tight and in good repair.

(*d*) That a good quality naphthalene was used.

Shortly after the naphthalene is put down and the vapours begin to rise, adult spider on the leaves drop on short webs and hang struggling at their ends for many hours until movement ceases. The eggs tend to turn a reddish colour during fumigation, except those which have just been laid, the latter remaining white. No perforations could be found in the egg membrane and it is not known how the naphthalene vapour penetrates into the egg. On death the active and resting stages of spider turn a dull colour and only after a considerable time do they become black and dry up.

An atmosphere at a high temperature will contain much more naphthalene vapour than at a low temperature. It appears that the lowest temperature at which the atmosphere will contain enough naphthalene vapour to kill red spider in 24 hours' time is in the region of 74° F. Below this temperature even prolonged fumigation will not attain the desired end.

At temperatures above 74° F., the amount of naphthalene distributed must be capable of producing in the atmosphere a concentration of vapour equal to or above that contained in an atmosphere at 74° F. for a period of at least 24 hours. At the same time the naphthalene put down should all volatilise within 48 hours, for there is no means of getting rid of it except by evaporation. The amount used on nurseries (3 lbs. to 100 ft. run of single border) fulfils this condition up to a point but as yet we are in doubt whether less would not be sufficient. Smaller quantities could conveniently be mixed with some other substance such as finely ground lime to ensure even distribution over the whole border, at any rate in average-sized houses.

(5) Size of Houses treated.

Under very favourable conditions (high temperatures and sunlight) the effect of naphthalene vapour was the same in the largest " aeroplane " houses as in small houses, although the same amount of naphthalene was used to the run of border. To some extent this indicates that the amount used for small houses has been more than necessary, but it must be remembered that arching over of the plants in large houses does much to concentrate the vapours within the area actually occupied by the foliage.

(6) Leaky Houses.

A number of fumigations were made in houses where the " closed " ventilators left gaps of several inches. At rather low temperatures the spider were not killed ; at high, only those at the back of the borders, those on upper leaves of the plants and many thousands hanging in their webs from the ridge-capping being only temporarily paralysed. By distributing upon the path an additional quantity of naphthalene equal to that on the two borders of each house, full efficiency was obtained in some cases.

(7) Distribution of Naphthalene in Houses.

When the naphthalene was allowed to fall in heaps on the borders, instead of being thrown forcibly, the vapour concentration was hardly enough even to affect the spider and days elapsed before the naphthalene had evaporated. In houses where two rows of plants were grown from one border, each half was treated as a whole border. Though this was effective, it is possibly better to utilise the paths for distribution of the naphthalene left over, in which case the paths should not be too wet.

Naphthalene being volatile in steam, it is advantageous to water the borders shortly before distribution but on a path the low temperature produced by watering may prevent evaporation almost entirely.

(8) General Conditions prevailing during Fumigation on Nurseries.

The conditions encountered during the summer were abnormally unsuitable for naphthalene fumigation. Heat and light, the two main factors for success, were mostly lacking. For experimental data, on the other hand, the conditions were ideal, as a series of fumigations in hot bright weather would have been little more than repetitions of successful treatment at the experiment station and on a few nurseries in June.

An adverse circumstance from the growers' point of view lay in the fact that many very naturally treated their houses at the very end of their crop, a time at which root action was

often weak and scorching followed. The ill effects to the grower were sometimes augmented by the action of the vapour upon old leaves, which should have been trimmed in the event of the crop being carried on. There were a few cases, however, where whole nurseries were saved from the necessity of replanting in the middle of the season and in which a crop was maintained to the end.

The treatment was not put forward as a finished process ; we maintain that the use of naphthalene as a fumigant for red spider is in its infancy and still requires adaptation to conditions This, however, by no means detracts from its value as the only fumigant ever used which will exert an economic control over red spider in cucumber houses.

Recommendations for Control of Red Spider in Cucumber Houses during the Growing Season.

As an outcome of the information gathered from experiments and the treatment of cucumber houses on nurseries, we make the following recommendations for the control of red spider :—

(1) Materials and Method of Distribution.

Pure Commercial White Flake Naphthalene in a dry state, which has been passed through a sieve of 16 meshes to the inch (= 256 meshes to the square inch), is broadcasted by hand on the borders at the rate of 3 lbs. to every 100 ft. of border. When broadcasting, force is used to ensure wide distribution over the border. Within usual limits, the dimensions of the houses do not affect the amount of naphthalene used. In leaky houses, the paths, on which excessive moisture is to be avoided, should be treated in the same manner as the borders, using 6 lbs. naphthalene to every 100 ft.

(2) Conditions for and Time of Fumigation.

The atmospheric temperature of the houses should not fall below 74° F. and not rise above 104° F. during fumigation.

The borders should be watered and the plants damped over shortly before the naphthalene is applied.

The naphthalene is broadcasted between 4.0 p.m. and 5.30 p.m. and the ventilators closed for the night. The next morning the ventilators may be opened for a few minutes to allow the fumes to escape, so that the worker may enter without inconvenience. The plants are damped over, care being taken not to wash the naphthalene off the borders. The ventilators are kept closed all day, unless it is necessary to put a little air on to prevent the temperature rising too high.

Late in the afternoon, the plants are damped over again and the ventilators closed. The naphthalene should have evaporated by the following morning, when the fumigation is at an end. One application is sufficient and a second fumigation should not be necessary until at least three weeks after the first.

(3) Treatment of Plants.

Old and useless leaves should be trimmed out before fumigation. If very serious scorch appears during fumigation, the plants should at once be damped over and the naphthalene washed off the borders with the hose. The ventilators should be kept closed. If, after fumigation is complete, the foliage has a brownish or yellow appearance, the houses should be well ventilated, and the plants well fed.

(4) Cutting of Fruit.

Arrangements should be made to cut fruit immediately before fumigation. Fruit should not be cut at any time during fumigation, as it is then liable to taste of naphthalene.

If it is necessary to cut immediately after fumigation is complete, the fruit should be exposed to fresh air, if possible at a high temperature for several hours before packing.

Vaporisation of Naphthalene from Hot-water Pipes.

Experiments were conducted in chambers of 350 cubic feet capacity with large and heavily infested pot-plants.

Pure commercial white flake naphthalene was placed in muslin and laid on the hot pipes.

Half-a-pound of naphthalene on the return pipe, 18 ft. long, took 8 days to evaporate, during which period the mean temperatures were as follows :—

Atmosphere	Day-time	Mean	81° F.	Maximum	94° F.	Minimum	67° F.
,,	Night-time	,,	71° F.	,,	81° F.	,,	61° F.
Pipe		,,	86° F.	,,	95° F.	,,	78° F.

Removed at intervals up to the third day (mean atmospheric temperature 71° F.) the spider still showed movement and eggs hatched.

On the 4th day the adults and active stages were mostly dead (mean temperature 80° F.). At the end of the 5th day, nearly all the resting stages were killed and the eggs failed to hatch when removed at the end of the 6th day (mean temperature 78° F.).

On the 13th day (5 days after the naphthalene had disappeared) a few spider were found alive, and it is probable that all the eggs had not been killed during the experiment.

The plants showed some yellowing of the foliage and there was slight scorching of a few leaves.

In a second experiment, carried out similarly, ½ lb. naphthalene was placed on the return and 1 lb. on the flow pipe. In 5 days time 15 ozs. naphthalene had been volatilised, the mean temperature being as follows :—

Atmosphere	Day-time	Mean 35° F.	Maximum	100° F.	Minimum	70° F.
	Night-time	,, 75° F.	,,	86° F.	,,	65° F.
Pipes		,, 87° F.	,,	98° F.	,,	76° F.

The spider were killed by the 3rd and the eggs by the 5th day. On the 4th day the temperatures were very high and the plants showed some slight scorching, but after the 5th day the foliage became very yellow and it was a long time before it became normal.

This experiment was repeated under very similar conditions with the same results. It will be noted that the naphthalene vapour only took effect upon the spider during periods when the temperature was high, this being in accordance with general experience.

This method of treatment is not practicable. In the first place strips of muslin are expensive, in the second it entails much time and labour to place the muslin and naphthalene on pipes in front of which plants are growing. However, both flow and return pipes were utilised in a house of 2,500 cubic feet, using 4 lbs. naphthalene in all. Though the temperatures were favourable, the spider were not killed. One trial was also given to the system on a nursery, where the return pipes only were treated with 10 lbs. naphthalene in a house 180 ft. long. The temperatures were low and the results nil. Far better results were obtained by painting molten naphthalene on. In this way 8 ozs. naphthalene were applied to the pipes in a house of 350 cubic feet. On the second day, after high temperatures, enormous numbers of adult spider had fallen from the leaves and appeared to be dead, but some young stages, just after moulting were still active. The naphthalene had then all evaporated, and an additional 4 ozs. were painted on the return pipe.

On the third day the spider, including all eggs, had been definitely killed.

The mean temperatures were :—

Atmosphere	Day-time	Mean 88° F.	Maximum	97° F.	Minimum	79° F.
	Night-time	,, 73° F.	,,	84° F.	,,	63° F.
Pipes		,, 87° F.	,,	95° F.	,,	78° F.

In this experiment young pot-plants were used in addition to older fruiting plants, and no trace of any injury to them could be found. As it is very inconvenient and unpleasant to treat the flow pipes situated at the back of borders by this method in a block of houses on a nursery, the return pipes only were painted with molten naphthalene. During the experiment, the heating system got entirely out of control, with the result that the naphthalene was all driven off in the course of two hours, with considerable damage to the plants.

There may still be possibilities in painting naphthalene on the return pipes of houses where the temperature is under control but owing to the fact that the temperature at one end of the pipe may differ from that at the other by more than ten degrees, we do not think that a very regular volatilisation of the naphthalene could be expected.

Experiments with Naphthalene in Tomato Houses.

Owing to the unusually severe attack of red spider in tomato houses during this season, many experiments were made in trying to adapt naphthalene treatment to tomato-house conditions.

These conditions are radically different from those prevailing in cucumber houses, as the night temperature and humidity are lower and ventilators cannot be kept closed without risk during the heat of the day. Further, a warm moist atmosphere without ventilation encourages mildew, a disease to be avoided under all circumstances.

(1) Distribution of 16 Grade Naphthalene on the Ground.

Experiments were first conducted in houses of 1,000 and 2,000 cubic feet capacity, distributing 1 oz. to 4 ozs. naphthalene (16 grade) over the whole soil surface at 6.0 p.m. During the following day the ventilators were kept open. In none of the experiments were the spider killed. When, on the other hand, the ventilators were kept closed during the day, the spider were killed as in cucumber houses, ½ oz. to 1 oz. naphthalene to the square yard being sufficient for the purpose. Next, six houses of 2,000 cubic feet each were fumigated for 12 hours at night as follows :—

(*a*)	Naphthalene ...	2 ozs. to the square yard.
(*b*)	Cyanide	½ oz. Sodium cyanide.
(*c*)	,, ...	½ oz. Sodium cyanide, naphthalene 2½ ozs. per sq. yd.
(*d*)	Tetrachlorethane	10 fluid ounces.
(*e*)	,,	20 fluid ounces, naphthalene 2½ ozs. per sq. yd.

In no case were the spider killed, so that cyanide and tetrachlorethane do not affect spider in the presence of naphthalene vapour.

Mixtures of lime and naphthalene were applied to the soil in the hope of obtaining a volatilisation of naphthalene sufficiently rapid to kill the spider in one night but all the trials failed in their object.

(2) Experiments in Tomato Houses on Nurseries.

Some growers tested naphthalene grade 16 on a very large scale, distributing it at the rate of ½ oz. to 1 oz. to the square yard of ground surface.

When temperatures were low or the ventilators were opened during the daytime, there was no marked effect. The volatilisation appeared to be assisted by watering the ground surface before application but spraying the plants over with water after a night's fumigation, when many spider were hanging from their webs in a paralysed condition, did not seem to have much effect.

One grower, however, treated a large nursery and kept the ventilators closed for 48 hours during a spell of hot weather. The results were remarkable.

The spider were killed to such an extent that a month later the plants had put out fresh green foliage with abundant growth and a good crop was obtained till the end of the season. The attack of spider had been so severe throughout the nursery, that in a number of places groups of plants had actually died.

By this treatment, however, one whole truss was completely lost through high temperatures prevailing in the houses during fumigation. It remains to be seen whether the injury thus sustained would justify the treatment being made a commercial practice.

(3) The Effect of Naphthalene on Tomato Plants and Fruit.

The tomato plant is far less susceptible to injury from naphthalene vapour than the cucumber. Scorching of the foliage—mostly near the growing point—has only been produced when finely divided naphthalene has actually been thrown over the plants, or when large volumes of vapour have been generated in a short space of time, so as to cause condensation upon the leaf surface.

The fruit, on the other hand, takes up the taste to rather a greater extent in the case of ripe fruit, less in the case of green fruit. As with cucumbers, the taste soon disappears on exposure to fresh air.

(4) Vaporisation of Naphthalene from Fumigators.

The vapours of naphthalene become distributed with considerable rapidity in a glasshouse, a fact which suggested the possibility of using a fumigating apparatus. The source of heat must be a strong one, as it is necessary to raise the temperature of a vessel containing some 10 ozs. naphthalene considerably above 212° F. Further, the vapour should come off regularly over a period of about 12 hours, in order to avoid an excess of vapour at any one time and a consequent condensation of solid naphthalene in various parts of the house. Ten ounces naphthalene was evaporated in 12 hours time at a temperature of about 70° F., by using a tin vessel, 5 inches high and $3\frac{1}{4}$ inches in diameter, placed 3 inches above the wick of a spirit lamp with $\frac{1}{4}$-inch diameter wick and containing 6 ozs. methylated spirit.

The vaporisation was not regular, as the naphthalene took some 45 minutes to melt completely, after which its temperature gradually rose until the boiling-point of naphthalene (422° F.) was approached as the last ounce volatilised.

On a warm night, with pipe heat on, two fumigators of the type indicated, each containing 10 ozs. naphthalene, were used in a tomato house of 2,000 cubic feet capacity. The plants had grown right up to the ventilators, the house being 13 feet to the ridge. The next morning, leaves with spider were collected from every part of the house and all had been killed. The experiment was repeated, using less naphthalene (5 ozs. and 8 ozs. per 1,000 cubic feet), but this was not sufficient to kill the spider in one night. On another night, however, the temperature fell very much during the fumigation, with the result that naphthalene condensed and the foliage was considerably scorched.

The temperature of the air not only affects the rate at which vaporisation takes place but also the rate of burning of the spirit and the heat given by the flame. With so many variable factors at work, it seems almost hopeless to utilise this method for naphthalene fumigation, apart from the number of fumigators which would be necessary for a large block of houses. Candles and night-lights do not appear to give nearly enough heat for evaporating naphthalene on the lines indicated.

(5) Utilisation of Hot-water Pipes.

There seem to be two possible ways of applying naphthalene to hot-water pipes. The naphthalene should be in actual contact with the pipe, as the smallest air-space between causes much loss of heat.

The best method yet found is first to water the surface of the pipes and then pour molten naphthalene upon them. On a large scale, a special kettle would be necessary for the purpose. Painting

the molten naphthalene upon the pipes with a brush is a more laborious and an unpleasant process. The other method is to stir naphthalene (16 grade) and water together in a bucket, adding enough water to make a thin soup ; this is applied with a brush, but here again the procedure on a large scale would involve much time and labour.

This form of treatment is still under investigation, and success is dependent upon atmospheric temperature.

Fumigation of Other Plants in Glasshouses.

As is well known, vines and carnations grown under glass suffer much injury from Red Spider.

With vines no experiments have as yet been carried out. Carnation plants in pots, heavily infested with spider, were fumigated by broadcasting 16 grade naphthalene over the pots and staging at the rate of ½ oz. to the square yard of surface.

The spider were only killed if the ventilators were kept closed for a night and a day, at temperatures above 74° F. Naphthalene falling upon the bloom and foliage did not appear to cause any injury.

Dusting plants with a mixture of lime (70%) and naphthalene (30%) in a very fine state of division affected the spider only temporarily at temperatures in the region of 64°F. The naphthalene volatilised very quickly, and it is thought that there was some scorching of the tips of older leaves ; the blooms were unaffected.

At the end of August a grower of carnations treated his houses, using 1 oz. naphthalene per square yard of bed, which was first well watered. The ventilators were kept closed for 36 hours and the temperature did not fall below 70° F. The spider were reported killed and no damage to the plants or bloom was recorded ; but the success of this one experiment does not establish the use of this treatment generally, as high temperatures are not favoured by growers of these plants. Less naphthalene could certainly have been used, as much remained on the beds after the spider had been killed.

Winter Treatment.

(1) Cucumber Houses.

Cucumber houses at the Experimental Station were fumigated with 16 grade naphthalene just prior to taking out the plants at the end of the season. The pipes were heated to a good temperature, 6 lbs. naphthalene being broadcasted on the borders and 6 lbs. on the path of a 78 foot house. Boxes and tins with small holes in the lids and containing living spider were placed in various positions in the house, and the ventilators closed down.

Thirty-six hours after the naphthalene had been distributed all spider on the plants and those situated between the bars and the ridge-board of the house were dead but those in the boxes and tins showed some movement. After two days and two nights, the naphthalene was all volatilised from the borders, but much remained on the paths. Many spider in the tins and boxes recovered subsequently, but when a second application was made to the borders, the naphthalene took permanent effect, showing that it will slowly penetrate into small crevices.

It is therefore advisable to treat the borders only, and to give two applications at the rate of 3 lbs. naphthalene (16 grade) to 100 foot run of single border, the second application being made two days after the first. The houses are kept closed for four days. The treatment should be repeated a week before the plants are put in at the beginning of the season.

In all cases as high a temperature as possible should be maintained.

(2) Tomato Houses.

Before removing the plants at the end of the season and one week before planting, 16 grade naphthalene should be broadcasted all over the ground surface of the houses at the rate of 1 oz. to the square yard and the ventilators kept closed until the naphthalene has volatilised.

From the following experiment it will be seen that the treatment is absolutely useless unless a temperature well above 70° F. is maintained in the houses day and night.

In a block of four tomato houses, each 100 feet by 27 feet, 92 lbs. naphthalene were broadcasted over the soil surface, and 20 lbs. were placed on the pipes at the beginning of December. For six days and nights the pipes were heated and the ventilators kept closed. Banana plants infested with spider and canes containing hibernating spider were placed in the houses.

The mean temperatures maintained were as follows :—

Atmosphere ...	Mean 60° F.	Max. 67° F.	Min. 54° F.
Flow-pipes ...	,, 84° F.	,, 96° F.	,, 71° F.
Return-pipes ...	,, 76° F.	,, 86° F.	,, 67° F.

Mean temperature of pipes, 80° F.

On the sixth day of fumigation the naphthalene had all volatilised, but the spider on the plants and in the canes had not been affected. During the experiment, observations were made on other animals in the houses : certain soil-infesting beetles and flies, ordinary spiders, the millipede (*Orthomorpha gracilis*) (common

also in cucumber houses), many woodlice (*Armadillidium vulgare*), and apparently pupæ of the Tomato Moth (*Hadena oleracea*) and click-beetles were killed by the fifth day of fumigation. Red spider and another millipede (*Blanjulus sp.*) were not killed.

Up to the fifth day naphthalene condensed on the glass of the houses at night and even on the banana plants.

We do not think that it is economically possible to raise the temperature of houses built in blocks sufficiently to attain a concentration of naphthalene vapour strong enough to kill red spider in winter, with low temperatures prevailing outside.

(3) Fumigation by Burning Sulphur and Evaporating Ammonia

Sulphur was burnt at the rate of 1 lb. to every 1,000 cubic feet space in a tomato house 100 feet in length. Spider on the exposed leaves of plants were unaffected by the fumes, which persisted for rather less than 24 hours.

Fifteen fluid ounces .880 Ammonia were allowed to evaporate in a house of 2,500 cubic feet space. Red Spider and various insects were unaffected by the fumigation.

(4) Treatment of Canes.

When canes are treated with boiling water to kill red spider within them, they are often dipped in troughs of boiling water. To ensure success it is necessary to keep them under the water for a considerable time, as their immersion causes a lowering of the water temperature and it takes some time to raise them to a temperature sufficient to kill the spider.

Canes were placed in a steam-steriliser, with boiler pressure of 50 lbs. : the pressure rose to 11 lbs. in the steriliser when the steam was admitted, and all spider in the canes were killed in two minutes time. Under ordinary circumstances the canes would be left in much longer, and it is thought that this method is far more economic than boiling the canes in water.

Now that the attack of spider in tomato houses has assumed a serious aspect, the use of canes in houses cannot be too strongly deprecated.

(5) Ridge Capping.

Red Spider are known to harbour in vast numbers beneath the ridge capping of glasshouses. From this situation they have constant access to the houses and are so placed as to defy attempts to destroy them.

At least one grower has realised that the usual construction of ridge capping is a menace to the cultivation of plants under glass from the point of view of red-spider infestation. It is therefore urged that growers should investigate either the possibility of dispensing with the ridge capping or of replacing it by some easily removeable structure which can be cleaned in the winter.

Woodlice.

Experiments in the use of poisoned baits for the control of Woodlice (*Armadillidium spyeri* Jackson) in cucumber and tomato houses have led to the possibility of this method becoming economically efficient. They have shown that baits in the form of oatmeal, middlings, or flour, lose a great proportion of their attractiveness when moistened with water.

Paris green (Copper aceto-arsenite) previously found quite ineffective in moist baits, has given excellent results when mixed with dry oatmeal (coarse) and flour. Lead chromate and calcium phosphide killed no woodlice in the experiments ; sodium fluoride and lead arsenate, very few. Potassium bichromate was uncertain owing to its rapid absorption of water.

The minimum quantity of Paris green necessary to produce an average mortality in an oatmeal bait was determined to be 2.5%. This was arrived at by placing woodlice in jars of soil and a small heap of each bait on the surface :—

Basis of Bait.	Poison.	Attractive Agent.	Percentage Woodlice killed in 2 days.
Coarse Oatmeal ...	Paris green .5% ...	White sugar 10% ...	5
,, ,, ...	,, ,, 1.0% ...	,, ,, 5% ...	60
,, ,, ...	,, ,, 2.5% ...	,, ,, 5% ...	90
,, ,, ...	,, ,, 5.0% ...	,, ,, 5% ...	85
,, ,, ...	,, ,, 5.0% ...	,, ,, 5% ...	85
,, ,, ...	,, ,, 10.0% ...	,, ,, 10.0% ...	85

Using 2.5% Paris green, the sugar content was varied :—

Basis of Bait.	Poison.	Attractive Agent.	Percentage Woodlice killed in 2 days.
Coarse Oatmeal ...	Paris green 2.5% ...	None	100
,, ,, ...	,, ,, 2.5% ...	White sugar 2.5% ...	100
,, ,, ...	,, ,, 2.5% ...	,, ,, 5.0% ...	60
,, ,, ...	,, ,, 2.5% ...	,, ,, 10.0% ...	100
,, ,, ...	,, ,, 2.5% ...	,, ,, 20.0% ...	90
,, ,, ...	,, ,, 2.5% ...	Brown ,, 10.0% ...	25
,, ,, ...	,, ,, 2.5% ...	,, ,, 20.0% ...	15

In experiments of this nature, and carried out in the winter, figures showing percentage mortality are bound to be variable. It appeared that no particular advantage was gained in adding white sugar, and that brown sugar, through its quick absorption of moisture, definitely lessened the attractive properties of the oatmeal.

An additional test was made to verify the indications of the last experiment, each test being repeated five times.

Basis.	Poison.	Attractive Agent.	Percentage Woodlice killed in 24 hrs.	48 hrs.
Coarse Oatmeal ...	Paris green 2.5%	... White sugar 10%	88	99
,, ,, ...	,, ,, 2.5%	... None	94	100

No advantage was thus gained in adding sugar.

Additions of small quantities of saccharin, chalk, calcium oxalate, calcium phosphate, ammonium sulphate, and amyl acetate did not increase the attractive qualities of coarse oatmeal, while lime definitely kept the woodlice away.

Knowing that some 90% woodlice would be killed with baits containing 2.5% Paris green, experiments were set up to improve the basis of the bait. Coarse oatmeal, fine oatmeal, middlings and flour were used for this purpose. Each of these was poisoned with Paris green (2.5%) and placed in a small heap in jars containing soil and woodlice: small heaps of the three other materials, unpoisoned, were then added to each jar. Thus, one jar would contain a heap of, say, middlings poisoned, and heaps of coarse oatmeal, fine oatmeal and flour all unpoisoned, another coarse oatmeal poisoned, and heaps of fine oatmeal, middlings and flour all unpoisoned and so on. It was expected that the woodlice would choose the basis they preferred most in each jar. As controls a series of four jars were used, each containing a single heap of each baits poisoned, to get a percentage mortality for each bait used.

Basis of Bait.	Poison.	Percentage Woodlice killed. 1st day	2nd day	4th day
Coarse Oatmeal	Paris green 2.5%	50	90	100
,, ,, with other bases	,, ,, 2.5%	10	30	30
Fine Oatmeal	,, ,, 2.5%	40	70	70
,, ,, with other bases	,, ,, 2.5%	0	0	0
Middlings	,, ,, 2.5%	40	70	70
,, with other bases ...	,, ,, 2.5%	30	40	40
Flour	,, ,, 2.5%	60	90	90
,, with other bases	,, ,, 2.5%	20	30	30

The results indicate that coarse oatmeal and flour are good bases, but that woodlice do not pick any one of them out as being especially palatable.

On the assumption that something might be lacking in the mixing of Paris green with the finer materials, the whole experiment was repeated with double the quantity of poison.

Basis of Bait.	Poison.	Percentage Woodlice killed. 2nd day	3rd day
Coarse Oatmeal	Paris green 5%	40	70
„ „ with other bases	„ „ 5%	0	50
Fine Oatmeal	„ „ 5%	50	60
„ „ with other bases ...	„ „ 5%	10	10
Middlings	„ „ 5%	50	50
„ with other bases ...	„ „ 5%	10	10
Flour	„ „ 5%	90	100
„ with other bases	„ „ 5%	30	30

The percentage of deaths appears to be increased where a large quantity of Paris green is used with flour and decreased with coarse oatmeal. Mixtures of coarse oatmeal and flour were now used with Paris green, one series without flour being kept as a control : all were duplicated.

Basis of Bait.	Poison.	Percentage Woodlice killed. 1 day.	6 days.
Coarse Oatmeal 47%	Flour 48% Paris green 5% ...	37.5	82.5
„ „ 73%	„ 24.5% „ „ 2.5% ...	90	92.5
„ „ 72%	„ 23% „ „ 5% ...	87.5	100
„ „ 95% ...	... „ „ 5% ...	85	100

An increase in the poison content is therefore advantageous when the addition of a fine substance like flour is made. Finally, the best results were obtained by using coarse oatmeal, 90% ; white flour, 5% ; Paris green, 5%.

Preparation of the Bait.

It is essential to obtain finely powdered Paris green. This being highly poisonous, the following procedure is recommended : The ingredients—oatmeal (coarse), 1 lb. ; flour, 1 oz., and Paris green, 1 oz., are weighed out and placed in a large bottle with a tolerably wide neck. The bottle should only be filled up to three-quarters of its content. A cork is fitted, and the bottle thoroughly shaken. A hole, ½-inch in diameter, is made through another cork, and this replaces the unperforated cork when the bait is to be distributed. By this means the Paris green is prevented from getting upon the hands of the distributor. The original unpierced cork is replaced after use, to keep the bait dry.

Use in the Propagating House.

For the control of woodlice when propagating tomatoes, which are especially liable to destruction in the seed-box, the bait should not be scattered over the soil of the boxes. Though no damage appears to result to the seedlings, the oatmeal is liable

to go mouldy in a short time, and cannot be removed. It is best to scatter the bait lightly at the rate of rather less than 1 oz. to the square yard on the staging ; much of the bait falls through on to the ground beneath, where it is of great value. The seed-boxes are then placed on the bait.

As an experiment, three seed-boxes with tomato seedlings 1 in. high were placed in a propagating house badly infested with woodlice, and treated as follows :—

1.	Bait scattered over soil of box	Number of plants	40
2.	Bait scattered over staging round box	,, ,,	30
3.	Untreated	,, ,,	30

After one night dead woodlice were found beneath the staging. In the untreated box six plants had been destroyed, in the other two none.

After 2 nights an additional four plants were destroyed in the untreated box : in the soil of box 1, dead woodlice were found : neither in this or in box 2 were any plants injured. The control box was now treated as in box 1. No plants were lost subsequently from any of the boxes. For cucumber seedlings after potting a few granules of the bait have been placed round the stem of each plant with excellent results.

Use in Cucumber Houses.

As yet we have been unable to test this bait in cucumber houses with growing plants. After the plants had been removed, the bait was scattered over one border, and tested against a bait consisting of coarse oatmeal mixed with Paris green (2.5%). The bait which contained flour was far more effective than that which contained none, as many of the smaller woodlice which could not cope with the large granules of coarse oatmeal were killed in addition to the large woodlice.

Effect of Paris Green on Woodlice.

Woodlice feeding upon baits containing Paris green will, exceptionally, be killed in four hours : usually they show no effects for 16 hours. Prior to death they remain in a paralysed condition for as long as 24 hours, but no woodlice have been seen to recover from the poison, after symptoms of paralysis have set in. Woodlice will not move far to reach a bait, so that broadcasting seems to be an essential to success.

Other woodlice of cucumber houses, namely, *Armadillidium pictum*, Br., and *Porcellio laevis*, Latr., are killed by the bait recommended, and also *Armadillidium vulgare*, Latr., in tomato houses. We have noted this year that *Armadillidium speyeri*, Jackson, bred in cucumber houses for a much longer period than in previous years : females with young were found as late as September.

Effect of Naphthalene Fumigation on Woodlice.

After fumigating cucumber houses with naphthalene in the control of red spider, many thousands of woodlice have been found dead. This does not mean, however, that naphthalene fumigation is in any way a complete control for woodlice, for the latter are able to escape from the fumes if they can bury themselves easily in loose soil or get under clods of earth. As the borders of cucumber houses are often of a very loose nature, quite as many will escape as will be killed.

Carbon Dioxide Investigations.

O. Owen and P. H. Williams.

The work with carbon dioxide in the partitioned glasshouse was continued this year as described below. Concurrently a commercial apparatus for the supply of carbon dioxide was tested in house G. In the chambers, the arrangement was as shown in the accompanying diagram on Page 106.

The treatment in the individual chambers was as follows. **X1 and X4** received standard manurial treatment with no carbon dioxide. **X2** was divided into two plots, A and B. The plants in X2A were treated during 2 hours 40 minutes daily with 0.9% CO_2 from the time of sowing the seed to the stage when the plants were ready for planting out. The plants in X2B were grown under normal atmospheric conditions. *After* planting out, the plants in X2A and X2B were treated during 1 hour daily with 0.6% CO_2.

X3. It was our intention to use this chamber to examine the effect of exposing the plants to high concentrations (up to 3%) of carbon dioxide. For this purpose it was proposed to use the commercial apparatus which according to its makers would produce large quantities of carbon dioxide at will. In actual practice it was found impossible to obtain high concentrations of the gas. Consequently the treatment in this chamber was intermittent and the concentration of the gas rarely rose to 0.5%.

X5 was divided into two plots, X5A and X5B. In X5A the plants were treated with 0.9% between the time of sowing and planting out, while those in X5B were treated from the time of sowing to the potting up stage. From these stages, respectively, the plants received no additional carbon dioxide.

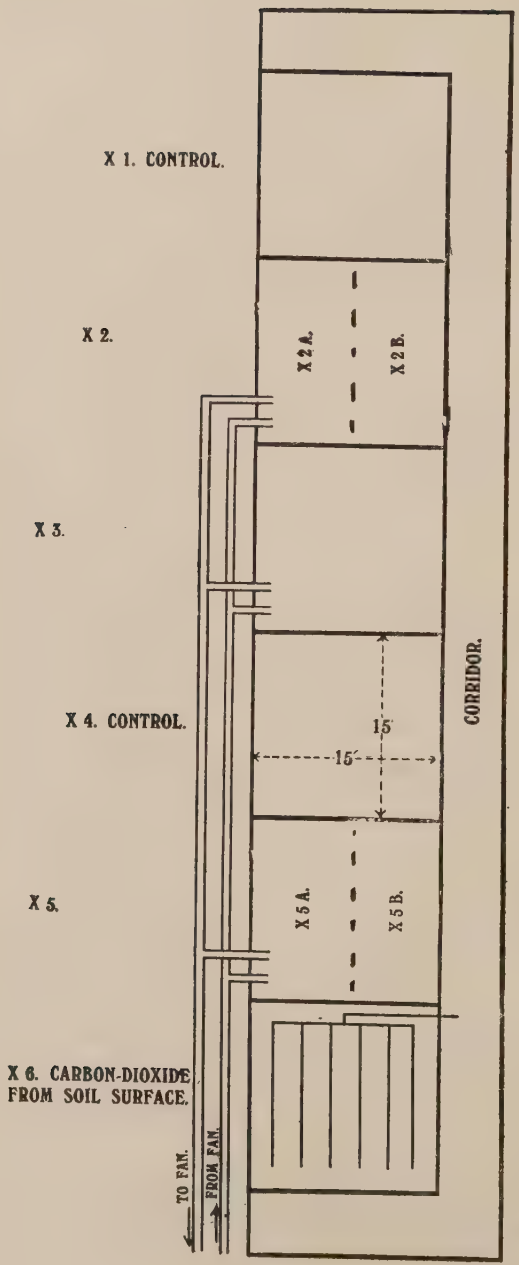
X6. The treatment here was the same as last year, the gas being supplied slowly through perforated pipes laid on the soil surface.

Each chamber contained 56 plants; the half plots in X5 and X2 consisting of 28 plants each. As far as possible, the temperatures in all the chambers were kept at the same level and continuous observations showed that in this respect the chambers were as uniform as could be expected.

From such an arrangement pickings should show:—

(1) In X2 the effect of a regular treatment with a definite amount of gas; (*a*) from sowing, (*b*) from planting out.

(2) In X3 the effect of intermittent treatment.


X 1. CONTROL.
X 2.
X 2 A.
X 2 B.
X 3.
X 4. CONTROL.
15'
15'
CORRIDOR.
X 5.
X 5 A.
X 5 B.
X 6. CARBON-DIOXIDE FROM SOIL SURFACE.
TO FAN.
FROM FAN.

(3) In X5 the effect of regular treatment :

(*a*) from sowing to planting out stage.

(*b*) from sowing to potting up stage.

(4) In X6 the effect of a slow evolution of gas at the soil surface.

The dates of the cultural operations were as follows :—

Seeds sown January 1st, 1924.

Plants potted into 60's January 28th, 1924.

Plants planted out February 29th, 1924.

The results are summarised in Table 1 :—

Table I.

		Lbs. per plant.	Tons per acre.
X1.	Control	8.59	51.54
X2*a*.	0.9% in boxes and pots, 0.6% after planting out ...	9.64	57.84
X2*b*.	0.6% after planting out	10.14	60.84
X3.	CO_2 from Commercial apparatus after planting out ...	8.91	53.46
X4.	Control	7.59	45.54
X5*a*.	0.9% in boxes and pots	8.54	51.24
X5*b*.	0.9% in boxes	9.21	55.26
X6.	CO_2 from soil surface	8.41	50.46
	Average of controls	8.09	48.54

An examination of Table 1 indicates a definite increase in crop as the result of the treatment (X2A and X2B and X3). The crops from X5A and X5B suggest that no additional benefit is likely to accrue from treatment in the early stages and this view is confirmed in X2B, where the plants which were *not* treated until after they were out gave a better crop than these which had been treated previously.

The increase in crop yield shown in X6 does not appear to justify the expense of supplying the gas in this way and it is thought undesirable to continue this part of the experiment any further.

In the Ninth Annual Report, mention was made of the incidence of root rot due to *Colletotrichum tabificum* in those chambers in which carbon dioxide had been used. This year examination of the roots showed that the attacks by this fungus were worst in X2, which had received most carbon dioxide.

Experiments with Commercial Apparatus.

This apparatus is of German origin, having been lent to the station by a German manufacturer. In it, carbon dioxide is made by burning coal or coke and, after purification, is absorbed by potassium carbonate solution. The mixture of potassium carbonate and potassium bicarbonate is then heated and the carbon dioxide so generated is pumped into the house. The residual potassium carbonate is pumped back to the absorber to take up more carbon dioxide and so the cycle may be repeated. The process is sound in principle and it should be possible by adjusting the strength of the carbonate solution and the combustion of the fuel to produce carbon dioxide in any amount and to control the rate of production at will. Unfortunately, the apparatus was found to be highly unsatisfactory in practice. In spite of much adjustment under the inventor's personal supervision it was never possible to obtain an average concentration of more than 0.06% in a house.

The results of this treatment on the crop are summarised in Table 2 :—

Table II.

Plot.	Manurial Treatment.	Lbs. per plant.	Tons per acre.
G1.	Mulch straw manure only	5.19	41.00
G2.	*Normal + mulch	4.75	37.53
G3.	Twice normal + mulch	4.50	35.55
G4.	Half normal + mulch	4.92	38.87
G5.	Normal, no mulch	5.40	42.66
G6.	Untreated	4.10	32.39
G7.	Half normal, no mulch	4.72	37.29
G8.	Twice normal, no mulch	5.13	40.52

* Normal treatment was as follows :—

Base-dressing.

1 lb. lime
¼ ,, bone meal
¼ ,, bone flour
¼ ,, ground hoofs
¼ ,, sulphate of potash
} per sq. yd.

Top-dressing.

Two ounces per sq. yd. of the following mixture applied during the second week in July, and every 14 days afterwards to end of September :—

5 parts dissolved bones.
7 ,, dried blood.
3 ,, superphosphate.
3 ,, sulphate of ammonia.
2½ ,, ,, potash.
½ ,, bone flour.

It is evident that the crops throughout are very ordinary and we consider that the apparatus in its present form is not likely to have any commercial possibilities. Improvements in its design are being undertaken and the experiment will be repeated with the modified apparatus in 1925.

These results cannot be considered conclusive since the apparatus cannot as yet be considered reliable.

Chemical Investigations.

O. Owen.

Soil Analysis.

The estimations of carbonates, total nitrogen and "available" potash and phosphates have been carried out in the plots in houses N, O, P and Q after the first crop. Owing to the restricted laboratory facilities, it has not been possible to carry out any other determinations on these soils.

The results offer no unusual information. In houses N, P, and O, owing to the application of manures, the "available" potash and phosphate, total carbonates, nitrogen and organic matter as determined by loss on ignition, have all increased. This, of course, is in accord with the well-known fact that a crop removes only a proportion of the plant food added in manures.

In house Q, where no lime has been added, no carbonates could be detected but the soil after the first crop gave no indication of being sour when tested by qualitative methods. The values for total nitrogen, "available" phosphate and potash have all fallen, the last named being exceptionally low. The organic matter, determined by ignition, is higher than it was before the plants were put in. This can be explained by the fact that turf was dug in in this block when the houses were erected and, in the course of a year, the green matter so incorporated in the soil, is probably sufficient to account for the observed increase.

A number of soils from various nurseries have been examined during the year. Generally the question to be decided was the necessity for the addition of lime. In one case only was there a deficiency, the soil being positively sour. This particular soil was of a peaty nature and had been treated liberally with organic manures. As a rule, soils in nurseries contain a fairly high amount of carbonate.

The use of Copper as a Fungicide.

It is well known that copper forms the basis of success of quite a number of fungicides. Such is the case with the mixture, known as " Cheshunt Compound," which has been successfully applied to the control of " damping off." In fact its success against this particular disease has led to its somewhat indiscriminate use on nurseries. Having regard to the poisonous action of copper on plants it was considered desirable to determine what amounts plants will tolerate in soil.

For this purpose a number of experiments have been carried out on a compost consisting of 4 parts of soil and 1 of manure, containing copper in the form of sulphate and in the form of " Cheshunt Compound."

In the case of 1 oz. copper sulphate in 10 lbs. of compost, it is remarkable that even when the compost has been washed so thoroughly that no more copper can be detected in the washings, germination of tomato seeds is considerably retarded and most seedlings show an effect of the poison three days after germination. Under similar conditions, larger plants show the poisoning effect three days after planting. The roots are invariably in a very weak state and while the plants may remain upright they do not grow or make any visible progress. When the copper is added as " Cheshunt Compound " the plants are indifferent to appreciably larger amounts. From a number of experiments we conclude that when this solution is used as directed by the station, plants are not likely to be affected. It must be emphasised, however, that " Cheshunt Compound " is only an emergency measure and its repeated use, year after year, on the same soil, may produce undesirable results and this practice is to be strongly deprecated. Should copper be introduced accidentally into soil its effects on the plant can be corrected, if not entirely eliminated, by the addition of one pound of slaked lime per sq. yd. for light soils to two pounds in the case of heavy soils.

Removal of Soot from Glass.

In most nurseries deposits of soot on glass constitute a serious source of expense during the winter months. During an ordinary winter a fall of snow will generally remove most of the deposit but further cleaning is often necessary. The commonest method in use is that in which the glass is cleaned with water and brushes. Another method is that in which the soot is brushed off with a dry brush and the wind disperses it. In both these methods, a good deal of glass is broken and on old nurseries the expense of replacing broken glass is an item of no small expense.

With a view to curtailing this expenditure, a number of solutions have been tested. Water itself has practically no effect on the deposits when applied at ordinary temperatures. The same is true of dilute solutions of the following: nitric, sulphuric and hydrochloric acids, caustic soda, caustic potash, sodium and potassium carbonates and soft soap.

At higher temperatures, water, soft soap solution and sodium carbonate solution all have an appreciable effect on the deposit, providing they are applied to the glass with force. After a number of trials it was found that a solution containing soft soap and sodium carbonate (washing soda) made and applied as described below was satisfactory.

Preparation.

Into 50 gallons of water heated to a temperature of 130° to 150° F., 2 lbs. soft soap and 5 lbs. of ordinary washing soda are stirred until completely dissolved. The solution is then ready for use.

Application.

The solution at a temperature of 120° to 150° F. is applied to the glass by means of a hand sprayer or a power sprayer through a fairly fine nozzle. It is essential that power be used, otherwise no impression is made.

At the station, a Drake and Fletcher hand sprayer with a lance fitted with a No. 2 washer in the nozzle has given good results. The nozzle is held some three or four inches away from the glass and moved as quickly as the deposit is removed. By working from a gutter ordinary houses can be cleaned quite effectively and the soot washed into the gutter. It is desirable that as little as possible of the solution be allowed to find its way into the houses.

Quantities and Costs.

For a cucumber house 100 feet long, 8 feet high, and 14 feet wide about 50 gallons of solution are required and this would cost in material about tenpence or a little more. The time taken to clean a house of this size will vary with the thickness, age, etc., of the deposit. It is clear that, if carried out after a fall of rain, the process takes much less time than if carried out after dry weather.

Effect on the Houses.

The materials in the solution are not likely to affect the glass and since the clearing will ordinarily be done in winter or early spring, when rain can be expected, we do not consider it likely to have any deleterious effect on the woodwork.

Examination of Tomato Foliage.

In view of the characteristic appearance of the foliage of tomato plants grown in soils deficient in one of the main nutrients, investigations have been taken in hand to determine whether the symptoms can be associated with any peculiarities in chemical composition of the tissue.

At the end of the season typical leaves were taken from plants in J5, J6*a*, J7*a*, J8*a* and analysis is now in progress. So far the results are available only of the percentage ash and they are as follows :—

Plot.	Nutrient omitted.	Percentage Ash in Dry Tissue.
J5.	None	28.14%
J6*a*	Phosphate	34.31%
J7*a*	Nitrogen	29.95%
J8*a*	Potash	30.68%

An examination of the ash in each case is now in progress. The figures given here are sufficiently different from one another to suggest a difference in the chemical composition of the plant tissue but comment on them is not justified at this stage.

Dates of Cultural Operations during 1923—1924.

Crop.	Sown.	Potted into 60's.	Potted into 32's.	Planted out in borders.	First Mulching.	First Top Dressing.	First Fruit Picking.	Last Fruit Picking.
Tomatoes	Dec. 17 1923	Jan. 21 1924	——	G. to M. Feb. 28. X. to Q. Mar. 4.	May 2 1924	*May 3 1924	May 14 1924	Oct. 31 1924
Cucumbers	Dec. 17 1923	Dec. 28 1923	Jan. 15 1924	Feb. 12 1924	——	Mar. 13 1924	Mar. 19 1924	Sept. 26 1924

* Plots J5, J6, J7 and J8 received one top-dressing when planted, and the second top-dressing on May 3rd, 1924.

Meteorological Records, 1924.

Month.	Rain.		Average outside Temperatures.		Bright Sunshine.
	Total fall. 5 inch Funnel Gauge.	No. of Rainy Days.	Day Maxm. °F.	Night Minm. °F.	Daily average in hours.
	Inches.				
January	2.83	16	44.4	35.5	1.51
February	0.71	11	41.5	32.1	1.70
March	0.84	8	48.3	31.8	4.88
April	2.94	14	54.1	38.1	4.90
May	3.96	28	63.2	46.4	6.29
June	2.00	15	67.3	51.1	6.90
July	4.11	23	71.1	52.2	7.73
August	2.09	26	66.5	51.4	5.28
September	2.90	19	62.8	51.3	3.88
October...	3.73	19	56.4	45 8	2.38
November	2.71	13	49.4	39.9	1.18
December	3.17	17	46.8	39.0	1.04
Total or Mean... ...	31.99	209	55.9	42.9	3.97

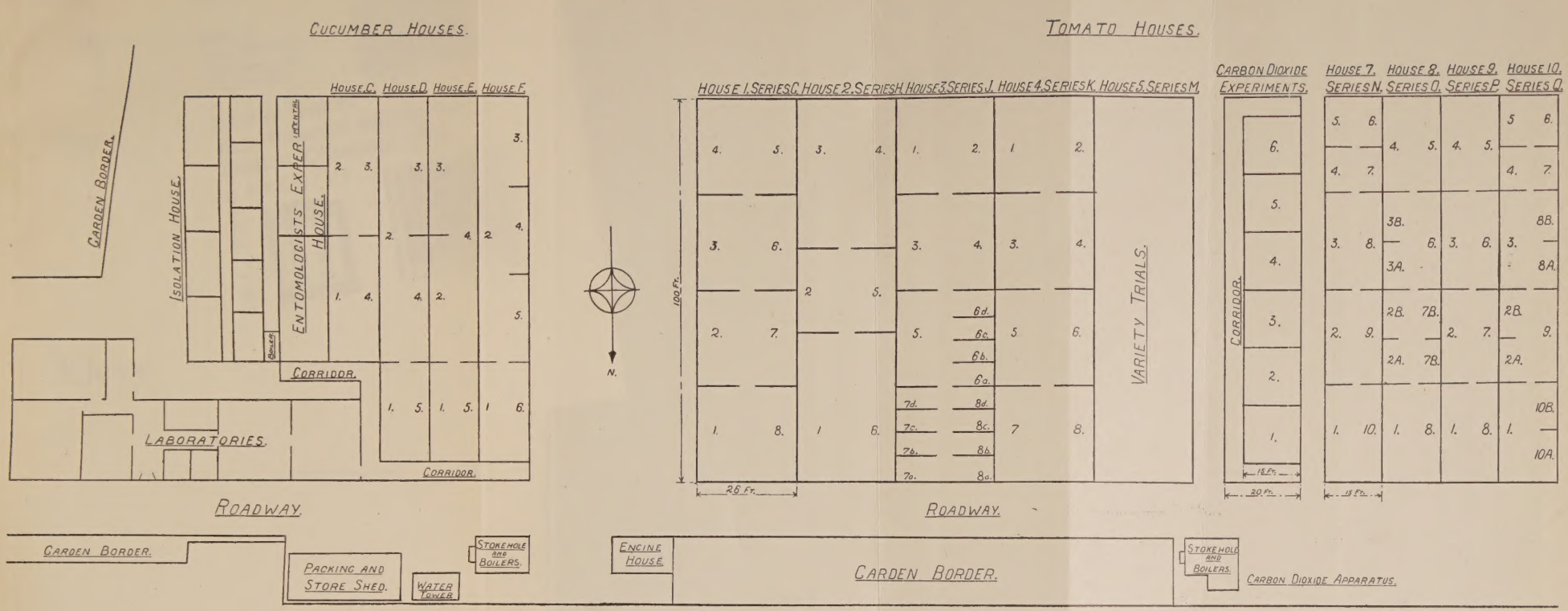


Diagram to show arrangement of Experimental Plots, 1925.